Power and The Engineer

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SOMETIMES a boiler will explode for no apparent reason, and again the condition of some boilers indicates no apparent reason why they should not explode.

Some engineers take the very best of care of their boilers and some take practically no care at all.

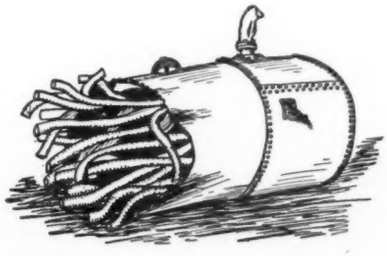
If a well made boiler, taken care of by an intelligent and conscientious engineer, explodes, the probabilities are that such an explosion could not be prevented by human intervention.

If a faultily constructed, neglected and abused boiler, in the hands of an ignorant, lazy and neglectful engineer, does not explode, it would seem that some watchful providence prevents the disaster.

Doubtless the accounts of the two boiler explosions published in last week's issue have been read. Both boilers were old; one over fifteen years, the other older. One killed thirteen men and injured forty; the other killed three men and injured six. One had been inspected, and the other had not, but both exploded.

As far as known, the boiler at Canton had been kept in good order, while the other was wholly unsafe to operate.

There is but one way to look at the practice of operating a boiler of uncertain age, one that has been twice discarded, exposed to the elements for a number of years, and then put to work as a steam generator carrying 110 pounds pressure. The man who does it, is careless to a criminal degree.



Accounts of boiler explosions are not published because they are amusing or because they are harrowing, but in order that the reader may profit.

If you are in charge of a battery of old, worn-out boilers, or only one boiler, and the explosion at Chewtown, Penn., does not sound a warning, than there is little use in saying more.

If the account of that boiler explosion has caused you to become uneasy regarding the condition of your boilers, and you are giving them your personal attention and are putting them in a safe working condition, then it has performed its mission.

Get after your boilers. Don't operate one you know is not in condition to operate. If you are in doubt, have a competent inspector look them over. Then follow his directions implicitly.

There are too many old boilers operating in an unsafe condition.

If the company you work for will not put its boilers in good working order, get another job. Dig ditches if necessary. It is safer and pays about the same wages.

Get rid of the old, worn-out, patched boiler, or it will get rid of you.

Marseilles' New Power Plant

By Dr. Alfred Gradenwitz

This recent addition to the system of the Marseilles Gas and Electric Company generates current at both 5500 volts and 13,500 volts, the former for supplying substations within the city limits and the latter for the outlying districts. The equipment represents the most uptodate practice, and when complete the plant will have a capacity of 14,000 kilowatts.

The power plant recently installed for the Marseilles Gas and Electric Company produces electrical energy under the three different conditions; viz., three-phase current at 5500 volts and 25 cycles; three-phase current at 5500 volts and 50 cycles; and three-phase current at 13,500 volts and 25 cycles.

The 5500-volt, 25-cycle current is utilized for feeding a substation situated in the center of Marseilles, where direct current is produced for a three-wire distribution line at 220 volts per conductor. The 5500-volt, 50-cycle current is utilized for supplying the outskirts of Marseilles through the intermediary of small transformer stations, where the potential is reduced to 190 volts; while the 13,500-volt, 25-cycle current is intended for supplying a special power system of the Marseilles Gas and Electric Company, which can also be fed from the Allauch substation.

Boiler Plant

The boiler plant consists of two distinct sections, feeding respectively four 1000-kilowatt and one 3000-kilowatt machines. The first of these (see Fig. 1) consists of twelve hand-stoked water-tube boilers, eight of which feed the 25-cycle machines, and the remaining four the 50-cycle machine, as well as insuring steam for a future turbine. The former are designed to furnish 6985 pounds of steam per hour at 185 pounds pressure under normal conditions, and 7700 pounds when being forced by a motor-driven blower; while the latter furnish 7920 pounds and 9240 pounds under these respective conditions. The steam passes through a superheater, which raises its temperature to 572 degrees Fahrenheit. Each of the boilers is connected with an economizer, which raises the temperature of the feed water to 176 degrees Fahrenheit.

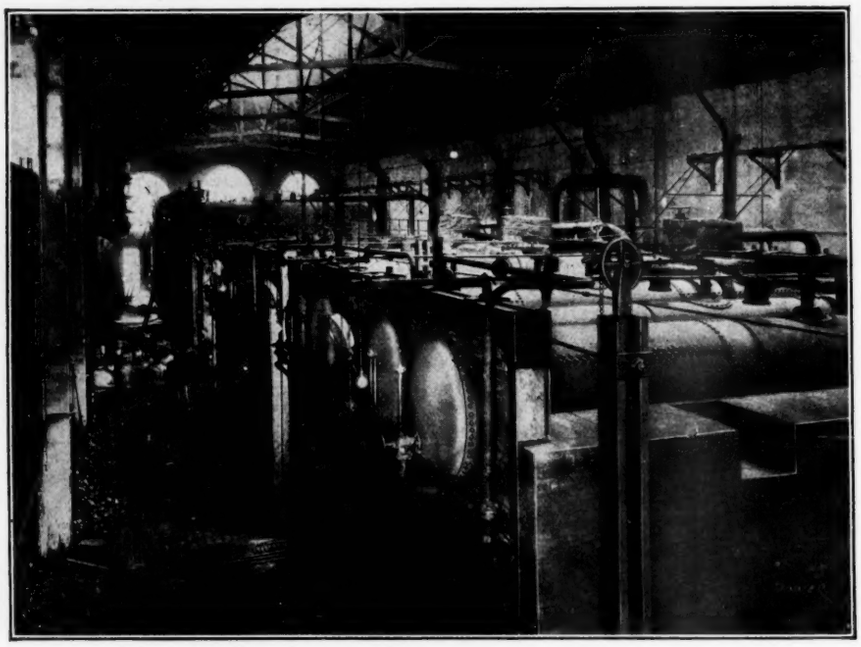


Fig. 1. First Section of Boiler Plant

These twelve boilers are fed by four feed pumps, two of the reciprocating type and two of the centrifugal type, all taking their supply from a common feed tank, into which the condensed steam of the turbines is led. The make-up water is obtained from an outside reservoir.

Coke is burned in these boilers and is brought directly from the gas works by a conveyer and dumped into the bunkers, situated at the backs of the stokers.

The second part of the boiler plant (see Fig. 2) consists of eight water-tube boilers, each of which under normal conditions produces 8800 pounds of steam per hour, at a pressure of 185 pounds per square inch, and 10,560 pounds under forced draft. These boilers are provided with automatic stokers, and like those in the first section are provided with economizers.

Generating Units

This part of the equipment consists of four turbo-alternator sets of 1000 kilowatts each, three of which produce three-phase current at 5500 volts and 25 cycles, and the fourth, three-phase current at 5500 volts and 50 cycles; a three-phase 3000-kilowatt turbo-alternator set, producing current at 13,500 volts, and 25 cycles (see Fig. 3); two frequency-changing sets of 500 kilowatts each; switchboards and all necessary auxiliaries. Space is also provided for an additional 1000-kilowatt and a 3000-kilowatt set.

A general view of the turbine floor is shown in Fig. 4. The turbo-alternators are of the vertical-shaft Curtis type, built by the French Thomson-Houston Company. The three 1000-kilowatt 25-cycle sets run at a speed of 1500 revolutions per minute under 165 pounds steam pressure and 150 degrees of superheat, and are able to handle an overload of 30 per cent. for two consecutive hours, or 50 per cent. for fifteen minutes. The regulation is effected by means of a centrifugal governor, with a safety device whereby the valve is closed when the turbine speed exceeds 15 per cent. above normal. A small motor-operated regulator controlled from the switchboard further allows the speed to be slightly altered for the purpose of synchronizing the various sets.

The rotating parts of these turbo-alternators are supported through their shafts by special bearings, while the shaft is maintained in its vertical position by three guide bearings, one situated just below the stud bearing, another at the middle, and a third at the top of the shaft.

Each turbine is supplied with a vertical surface condenser, to which a motor-driven centrifugal pump delivers 15,900 cubic feet of circulating water per hour. The same motor is belt-connected to the dry-air pump and the condensed-steam pump, the two latter being connected in tandem, as shown in Fig. 5. A vacuum of 27 inches is maintained under normal conditions.

The fourth 1000-kilowatt unit is prac-

tically identical with the three just described, except that it produces current at 50 cycles instead of 25.

The 3000-kilowatt, 13,500-volt, 25-cycle unit runs at a speed of 750 revolutions per minute, with a variation never exceeding 5 per cent., and is designed for handling an overload of 50 per cent. for two consecutive hours, or a momentary overload of 75 per cent. It is of the vertical-shaft type, the rotor being carried by a pivot bearing, situated at the top, and the lubrication is effected by oil at a pressure of 750 pounds per square inch.

In connection with this turbine there is a horizontal surface condenser having a cooling surface of 10,760 square feet. A motor-driven centrifugal pump supplies 53,000 cubic feet of circulating water per hour.

The circulating water for the condensers is obtained from two wooden cooling towers of the chimney type, situated close to the power house.

Frequency-changing Sets

The two 25- to 50-cycle frequency-changing sets which rotate at a speed of 500 revolutions per minute, each have a normal output of 500 kilowatts at 5500 volt. Each of the two machines of which they are composed has therefore an output of 750 horsepower when working as a synchronous motor. To each set is coupled a direct-current motor, which may be used either to start up the set, or to work as a generator when the set has once been started. It thus affords an auxiliary to the direct-current machine, and minimizes the risk of failure in the direct-current service. These sets are intended to feed the 50-cycle system jointly with the 1000-kilowatt turbo-alternator. Being reversible they also allow of the inverse function being performed.

The various alternators can be excited either by an engine-driven set of 75 kilowatts, which is used in first starting, or by three motor-generator sets. Two of the latter consist each of a 5500-volt motor running at 750 revolutions per minute direct-connected to a 125-kilowatt dynamo. The third set comprises a three-phase motor, running at 750 revolutions per minute and direct-connected to two dynamos of 50 kilowatts each. The motor of this latter set is supplied through transformers, which reduce the potential to 220 volts.

These transformers, six in all, are divided into two sets of three each. The first set consists of three single-phase, 25-cycle, oil-filled transformers of 75 kilowatts individual capacity, which reduce the potential from 5500 to 220 volts. The second set comprises three single-phase, 25-cycle transformers of 175 kilowatts eacn, which reduces the potential from 13,500 to 220 volts.

Either of these transformer sets can be used for feeding either exciter motor or the other motors driving auxiliaries in the power house. Means have, however, been provided for avoiding the possibility of connecting the 3000-kilowatt, 25-cycle turbine generator in parallel with any one of the 1000-kilowatt, 25-cycle generators, through the winding of these transformers.

Lubricating System

The lubrication of the lower bearings of the four 1000-kilowatt turbines is supplied by two water pumps driven by direct-current motors, each capable of delivering 16 gallons of water per minute, at a pressure of 370 pounds per square inch. Two oil pumps, each capable of delivering 17½ gallons per minute at a pressure of 170 pounds per square inch, supply the upper and middle bearings.

The lubrication of the 3000-kilowatt turbo-alternator is effected by means of three motor-driven oil pumps, shown in Fig. 6, two of which deliver eight gallons of oil per minute, at a pressure of 900 pounds per square inch, and the third 21 gallons per minute at a pressure of 170 pounds per square inch. A pressure-reducing outfit has been placed between the discharge receiver of the two

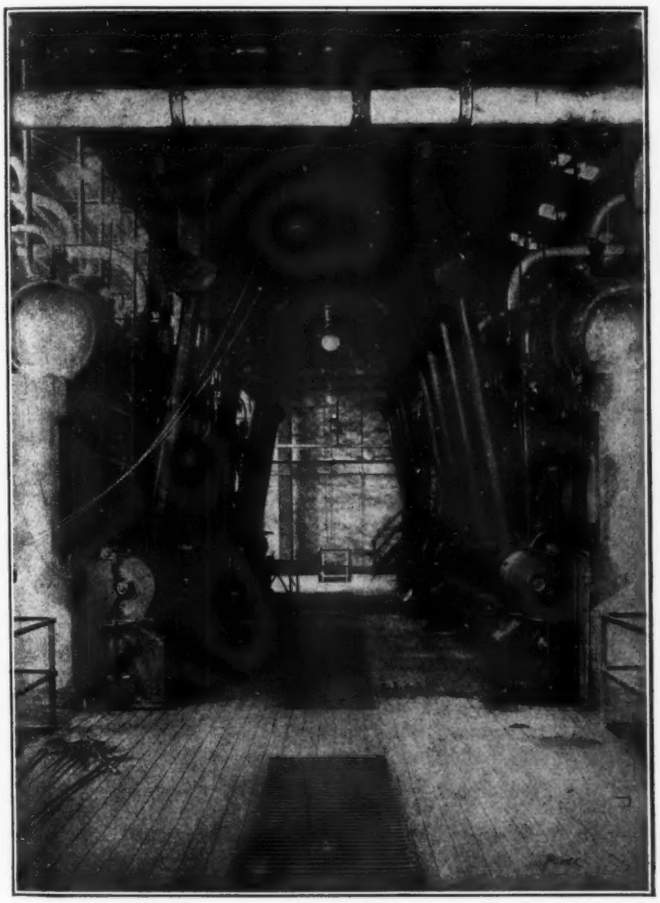


Fig. 2. Second Section of Boiler Plant

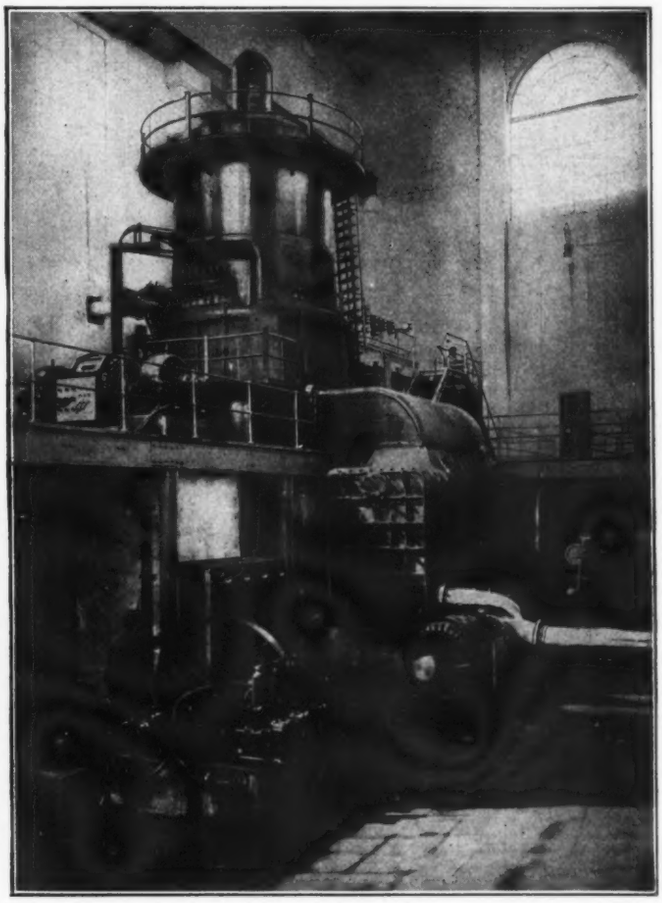


Fig. 3. 3000-kilowatt Turbo-Alternator

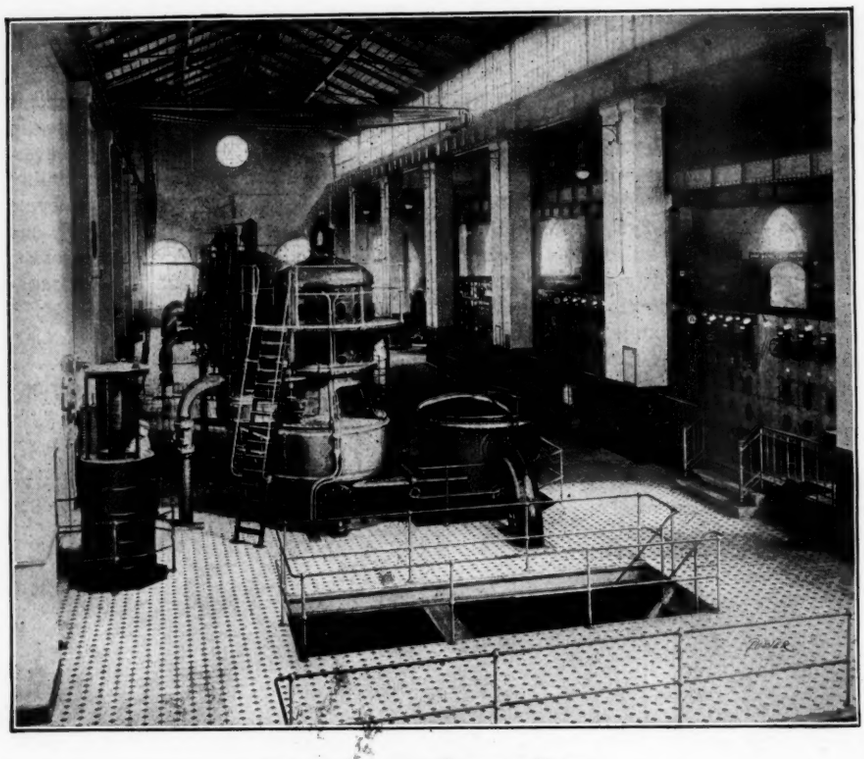


FIG. 4. VIEW OF TURBINE FLOOR

former pumps and the discharge receiver of the latter pump, thus allowing the high-pressure pump to be used as a reserve in the event of a breakdown of the low-pressure pump.

TRANSFORMERS

A transformer station allowing the 5500-volt, 25-cycle units in the power house to be connected to the 13,500-volt system, comprises three single-phase, 13,500- to 5500-volt transformers, each of 1000-kilowatt capacity. It is thus possible to transfer energy from the 13,500-volt power system to the 5500-volt system, or inversely.

SWITCHBOARD

The switchboard is divided into two main parts, one for the 5500-volt system, and the other for the 13,500-volt system. The 5500-volt switchboard consists of three sections, one for the direct-current service, another for the 25-cycle alternating current, and the third for the 50-cycle alternating current.

The direct-current section controls the switching devices and the direct-current machines. In order to avoid a drop in voltage in the exciter circuit of the alternator as a consequence of the starting of some generator set, the direct-current switchboard is provided with two sets of busbars, one supplying the excitation, and the other the various circuits, such as lighting, boiler-house motors, frequency-changing sets, etc.

The 25-cycle switchboard is likewise provided with two sets of busbars and contains four feeder panels, from which any of the cables starting from the power house can be fed in parallel; two generator panels for the 25-cycle synchronous machines of the frequency-changing sets, each of which can be connected to either of the two sets and carries means of controlling the starting of the motors of these sets; three generator panels for the turbo-generators, each panel containing the usual apparatus for the control of an alternator and also an interrupter for starting a small synchronous motor located at the turbine; one panel for the high-tension terminals of the service transformers; an incoming panel for the 13,500-volt circuit and two panels for the induction motors of the exciter sets.

The 50-cycle switchboard is provided with two sets of busbars and comprises two panels for the 50-cycle machines of the frequency changers; three feeder panels; and a panel for the fourth 1000-kilowatt turbo-alternator.

Some blank panels have been provided for the future addition of a second 5500-volt generator of 50 cycles and a third frequency-changing set.

This switchboard is completed by an automatic voltage regulator, acting upon the exciting current of the alternators.

The 13,500-volt switchboard shown in Fig. 7 is of the bench type and is located in an angle of the power house. It is designed to serve two 3000-kilowatt, 25-cycle alternators, only one of which has been installed, and comprises two incoming panels and six outgoing panels. Four blank panels have been provided, one being intended for a future transformer set, two for future incoming feeders and one for a future outgoing feeder.

All oil switches are of the Thomson-Houston type operated by motors and with remote control. Fig. 8 shows part of the switch structure.

A distinctive feature of this switchboard is that a simplified schematic dia-

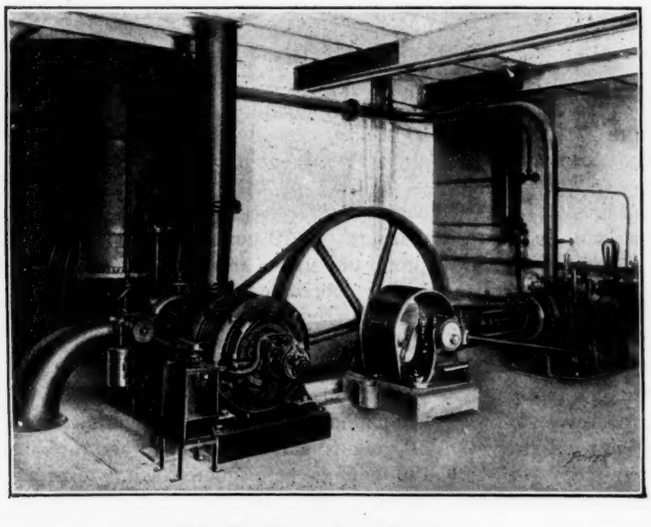


FIG. 5. CONDENSER PUMPS

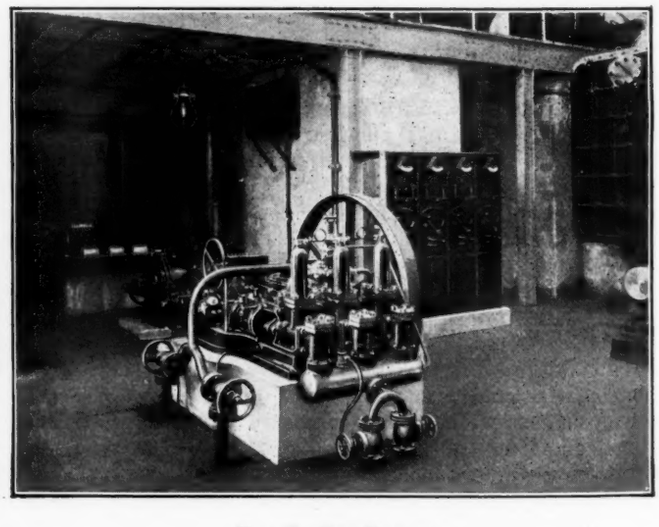


FIG. 6. OIL PUMPS

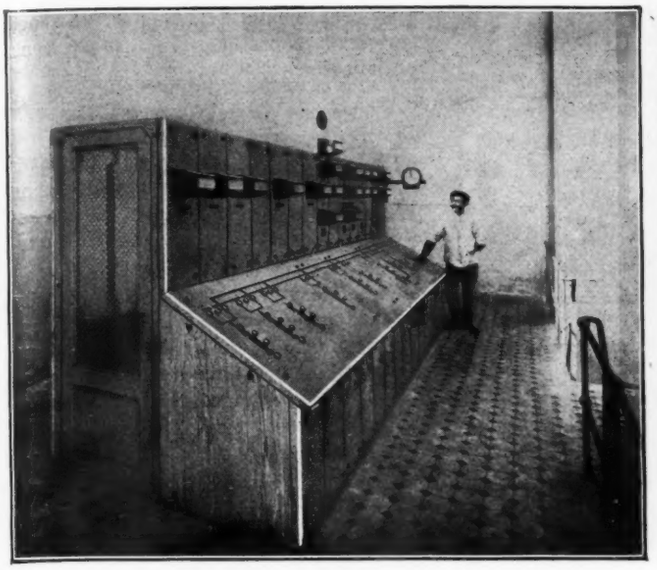


FIG. 7. 13,500-VOLT SWITCHBOARD

FIG. 8. OIL-SWITCH STRUCTURE

gram of the whole of the installation is engraved upon the operating desk. The oil-switch-control handles are provided with indicating lamps, which permit the man at the switchboard to see at a glance, if a given switch is open or closed. Furthermore, all the section switches are represented by numbers on glass plates which are lighted by electric lamps. Each of the latter is connected in series with a lamp bearing the same number and located close to the corresponding section switch. If the operator wishes to open or close a given section switch he sends an assistant to effect the operation, and as soon as this is accomplished the corresponding lamp is lighted or extinguished.

The total output of this power house will be, after the addition of the two proposed units, 14,000 kilowatts.

In the official tests made upon turning the plant over to the owners, the consumption of 14,450 B.t.u. fuel was found to be 2.16 pounds per effective kilowatt-hour delivered at the switchboard, which figure is considerably below the guarantee.

Choice of Power for Textile Mills*

By Charles T. Main

A discussion of the relative merits of steam and water power for operating textile mills, and containing tables showing the approximate costs of power with each type of installation.

Most of the earlier mills in New England were located upon the banks of a river, in order to take advantage of the water power; and in this way many of the manufacturing centers were started. With the advent of steam power, however, new centers grew up, many of which were located at some tidewater point where cheap fuel and low rates for transportation could be had.

Recently the transmission of electrical power and the use of such power in mills has caused remote and practically useless water powers to become useful; and has permitted the construction of central power stations at localities where fuel is cheap, at the same time allowing the mills to be placed advantageously with respect to labor centers and transportation facilities.

The chief items of cost in textile manufacturing are materials and labor, the power rarely costing over 5 per cent. of the total product of the mill. Hence, the relative importance of locating where power is cheap increases as the ratio of the cost of power to the cost of the product increases.

Nearly all costs of power at the present time are compared with steam power as a basis. The principal items affecting the cost of steam power are as follows:

1. Cost of fuel delivered to boilers.
2. Amount of power produced.
3. Fixed charges of cost of the plant.
4. Attendance and supplies.
5. The net cost is reduced in some plants where the waste heat is utilized in the process of manufacture.

STEAM-TURBINE PLANTS

In most textile mills the required power will vary from 1000 to 5000 kilowatts. Table 1 represents a fair average for costs in such plants.

It has been common practice for some time to use the exhaust steam from non-condensing engines or from the receivers of compound engines, for heating and manufacturing purposes. Impulse turbines lend themselves to this practice equally as well as the reciprocating engine, but with the reaction type the advantage is slightly decreased.

The saving by the use of exhaust steam is considerable. In some mills, especially color mills, if the power is not produced by steam, so that the exhaust can be used for manufacturing purposes, it would be necessary to maintain a boiler plant of sufficient size to produce an equivalent amount of low-pressure steam.

WATER POWER

The chief items affecting the cost of water power are as follows:

1. Quantity of water and uniformity of flow.
2. Head.
3. Location of plant.
4. Necessity of auxiliary steam for heating and manufacturing purposes.

If the flow is constant it is most valuable, for a variable flow requires to be supplemented by steam or other power. Also, the head is most important; the power derived from a definite quantity of water increases directly with the head, and the cost per horsepower of develop-

*Abstract of a paper delivered at the annual meeting of the National Association of Cotton Manufacturers, at Boston, April 27-28, 1910.

TABLE 1. COSTS IN STEAM-TURBINE PLANTS.

Size of Plant in Kilowatts.	1000	2000	3000	4000	5000
Cost of plant per kilowatt	$125	$110	$100	$95	$90
Total coal per kilowatt-hour in pounds	3	2.8	2.7	2.6	2.5
Yearly cost per kilowatt, coal at $5	$39	$34	$31.50	$30.25	$29.50
Cost per kilowatt-hour, in cents, coal at $5	1.34	1.17	1.09	1.04	1.02
Yearly cost per kilowatt, coal at $4	$35	$30.50	$28	$27	$26.25
Cost per kilowatt-hour, in cents, coal at $4	1.21	1.05	0.97	0.93	0.91

TABLE 2. COST OF UNIFORM HYDROELECTRIC POWER.

Size of Plant in Kilowatts.	1000	2000	3000	4000	5000
Assumed cost per kilowatt	$100	$100	$100	$100	$100
Yearly cost per kilowatt	$12	$11	$10.75	$10.50	$10.25
Cost per kilowatt-hour, in cents	0.41	0.38	0.37	0.36	0.35
Assumed cost per kilowatt	$200	$200	$200	$200	$200
Yearly cost per kilowatt	$21	$20	$19.75	$19.50	$19.25
Cost per kilowatt-hour, in cents	0.73	0.69	0.68	0.67	0.66
Assumed cost per kilowatt	$300	$300	$300	$300	$300
Yearly cost per kilowatt	$30	$29	$28.75	$28.50	$28.25
Cost per kilowatt-hour, in cents	1.05	1.01	1	0.99	0.98

TABLE 3. COST OF VARIABLE POWER AT SWITCHBOARD OF GENERATING STATION, WITH HYDROELECTRIC PLANT COSTING $100 PER KILOWATT AND COAL AT $5 A TON.

Size of Plant in Kilowatts.	Cost of Hydroelectric Power, Kilowatt-Year.	Fixed Charges, Steam Plant.	Total Cost When Steam Plant is Run for Different Number of Months.				
			One Month.	Two Months.	Three Months.	Four Months.	Five Months.
1000	$12	$11	$25.50	$28.00	$30.50	$33.00	$35.50
2000	11	11	24.50	27.00	29.50	32.00	34.50
3000	10.75	11	24.25	26.75	29.25	31.75	34.25
4000	10.50	11	24.00	26.50	29.00	31.50	34.00
5000	10.25	11	23.75	26.25	28.75	31.25	33.75

ment increases as the head diminishes.

It is rather difficult to give comparative figures on the cost of water power as the conditions vary to such an extent.

Operating Cost

A uniform power development at a reasonable cost is a valuable asset, while at a high cost it may not be profitable. A variable power at high cost, however, is pretty sure not to be profitable.

The above Table 3 shows in a general way the cost of power at the switchboard in the generating station, under varying conditions of cost.

To find the cost per kilowatt delivered at the other end of the transmission line, 5 per cent. should be added to the above figures for short lines and 10 per cent. for long lines.

Effect of Variable Power

That portion of the power which is uniform and which can be depended upon all of the time may be termed "permanent power," and that which is variable, "surplus or secondary power."

The effect of the latter is the necessity of a supplementary plant of sufficient capacity to make up the deficiency, in some cases the flow at times being so low as to require a supplementary plant of capacity equal to the regular plant.

The fixed charges on this supplementary plant go on whether it is used or not and must be added to the cost of power production which is shown approximately in Table 2.

With a variable water power requiring a double plant of water and steam, the conditions might easily be such that it would not pay to consider the water power, as the cost of maintenance and operation of the double plant might exceed the cost of steam power alone, not to mention the saving from the use of the exhaust steam.

Purchased Power

Some mills have the opportunity of purchasing power at a reasonable rate from a power company, which fact has certain advantages. If the enterprise is new, a smaller investment will be required and less space will be needed owing to the omission of the power plant.

All the foregoing figures have been made on the assumption that the mill is electrically driven, the advantages of which are many and need not be repeated.

Prevention of Smoke

While in Boston recently the editor passed a pleasant half hour with B. L. Ames, treasurer of the Climax Smoke Preventer Company. Among other things Mr. Ames told of a successful installation of the Climax smoke preventer on a Herreschoff water-tube boiler at the Crompton & Knowles Loom Works, Providence, R. I. He showed a report from the smoke inspector dated February 11, previous to the installation of the apparatus, which showed 28½ minutes of black smoke from 9:38 to 10:41 a.m. A second report dated April 28, after the Climax apparatus had been installed, showed a total of six minutes of gray smoke between the hours of 9:23 and 11:26 a.m. These readings were taken in the morning when they burn nothing but sawdust, shavings and wood.

The superintendent of the plant desired to take some readings between 7 and 8 in the morning, when the conditions were at their worst, and on May 4 such a test was made. During the hour the boiler was fired eleven times, and the average duration of smoke for a single period was between 10 and 20 seconds. The total was 3¼ minutes of gray smoke, but no black smoke.

Mr. Ames also confessed to having been one of several victims of an evident swindling game, publication of which he suggested might save others. It appears that in September last a likely appearing man, who represented himself as having an extensive acquaintance and facilities in Mexico and the southern part of Texas for the placing of engineering supplies, called upon him and signed a contract to represent his company in that vicinity, collecting a small sum in advance to be used for the printing of circulars in Spanish, etc.

He never heard from the man, but toward the end of October received a communication from the secretary of a company whose goods they also handle, asking if he was really their representative, saying that he had called upon them with the same proposition, but had made a hurried exit, with the dictum that it must be "now or never" when they suggested getting some reference in regard to him. As nothing has been heard from him since, Mr. Ames has concluded that he has been an "easy mark." In all probability the young man never saw Mexico and has no immediate intentions of visiting that country.

Curious Erosive Effect of Steam Jet

A small pipe supplying the steam jets of the stokers was passed through the flues of a Lancashire boiler to dry and superheat the steam before its delivery to the fire. A leak developed in the pipe close to the boiler shell plate and caused serious erosion.

The accompanying photograph, which appeared in the *Mechanical Engineer,* shows a remarkable erosive effect produced on a boiler plate by a jet of high-pressure steam. The boiler from which the plate was taken was of the Lancashire type, 30 feet long and 8 feet 6 inches in diameter, and was worked at a pressure of 160 pounds. The furnaces were fitted with mechanical stokers, and the steam for supplying the jets of these stokers was taken by a ¾-inch pipe from the top of the boiler into the right side external flue, and then into the bottom flue, where the pipe was enlarged to 1 inch diameter, and was then laid toward the back end of the boiler for about 13 feet, returning again to the front end, and then to the steam jets of the stokers. The object of taking the pipe into the external flues was to dry and superheat the steam as much as possible before delivering it to the fire. The pipe in use was apparently of wrought iron of the ordinary steam quality, and the joints and the bends were screwed in the usual way. A small leak developed in the ¾-inch pipe in the side flue which was laid close to the boiler-shell plate, and the escaping steam at high pressure impinged upon the side of the boiler shell. This action, in conjunction with the gritty particles in the flue dust, which were constantly being passed through the flue by the draft, wore away the boiler plate, which was ¾ inch in thickness, until the water side was reached. The sand-blast action appears to have stopped when the opening to the boiler pressure reached about ¾x1/16 inch in area. There was then considerable leakage from the boiler, and the defect was discovered.

The jet appears to have struck the boiler plate in a downward direction at an angle of about 60 degrees, making the edges of the upper end of the groove quite sharp. It will also be seen the curious fan-shaped markings are noticeable on only one side of the deep grooving, a peculiarity caused, no doubt, by the direction of the draft in the flue. The occurrence of this defect shows that the leading of steam piping of this description into the external flues of a Lancashire boiler is not satisfactory, as the piping is out of sight and cannot be examined under working conditions.

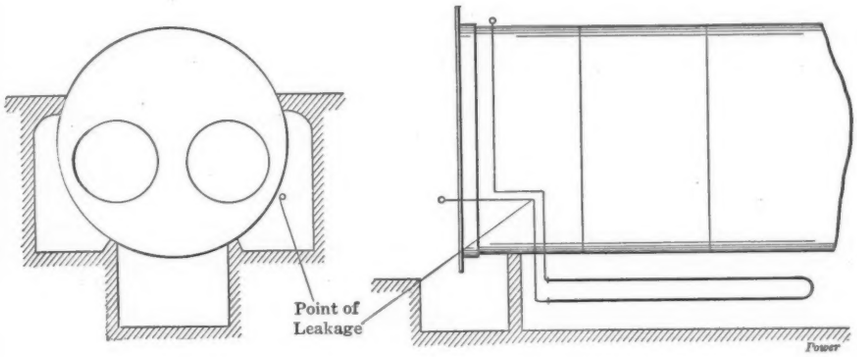


FIG. 1. ARRANGEMENT OF PIPING

A writer in a recent issue of *Machinery* describes a makeshift treatment for reducing the leakage of gas-engine pistons which in some cases might be available for air-compressor pistons, and those of air motors. The method is, briefly, as follows: Take out the piston and take off the rings. Clean the piston rings and grooves thoroughly. Get a piece of soft asbestos rope and before putting the rings back into place, wind some of the rope in the bottom of the ring grooves in the piston. Then soak the asbestos thoroughly with gas-engine cylinder oil, and put the ring back in the grooves. Put in enough of the asbestos rope so that the rings will have to squeeze it down fairly tight when the piston is pushed into the cylinder. This method may not be considered as a good mechanical job, but an old leaky piston when so treated will, after running a few minutes, be very tight, and may run for months before the operation of packing the piston ring needs to be repeated.

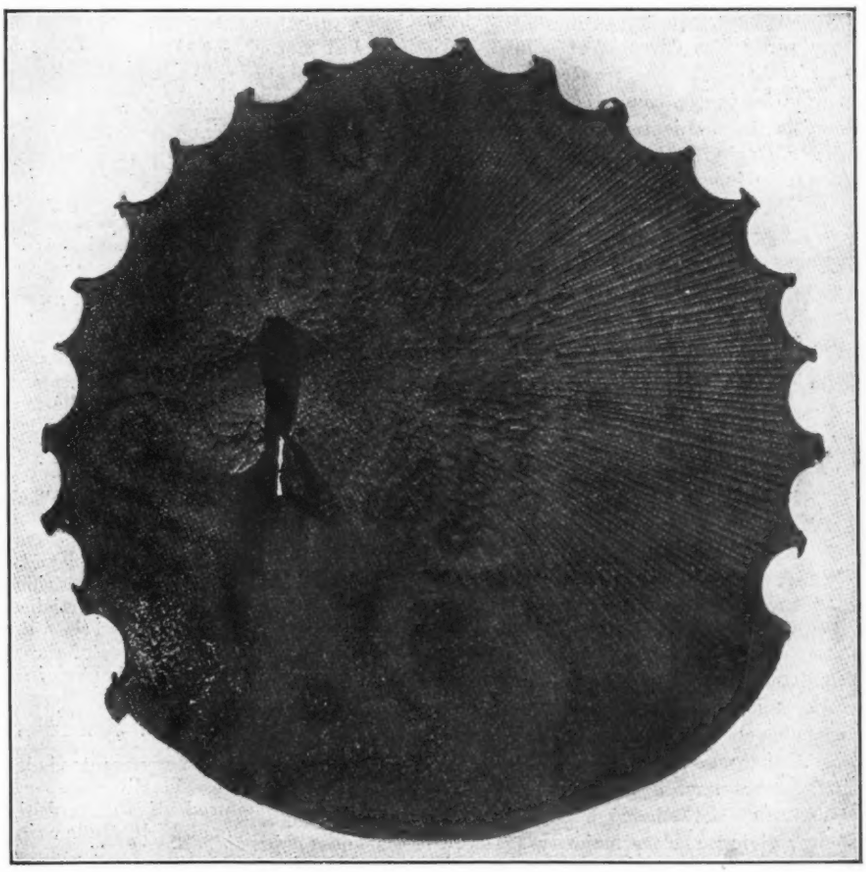


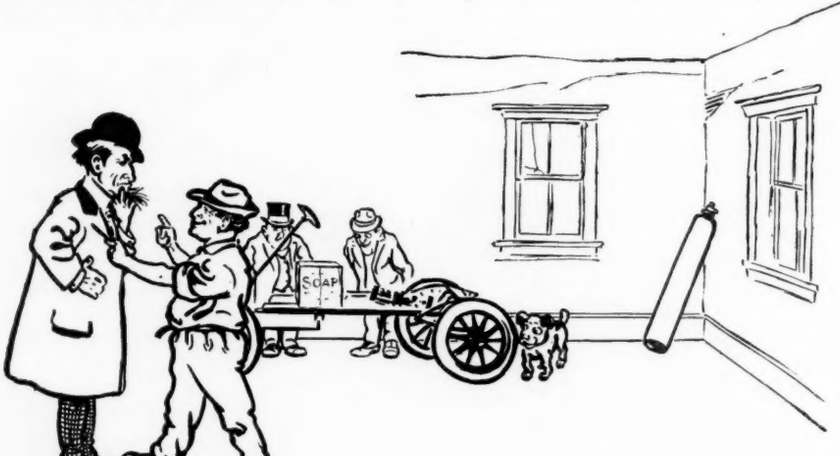
FIG. 2. PIECE OF BOILER-SHELL PLATE, SHOWING SAND-BLAST ACTION

Bill B. Banger Meets John E. Carroll

Bill visits Carroll's demonstrating room in Boston and watches the CO_2 motor drive an automobile. After sizing up the machine and reading over the prospectus of the company, he decides that gold-mining stock at 10 cents a share is the investment for him.

It ain't ther good fortune of most fellers ter see and talk with great inventors, but fortune has smiled a mite on me, and somehow or other guided my wanderin' footsteps ter John. Now John is a common enough name, but when it is coupled on ter ther rest of ther feller's cognomen and means John E. Carroll, it makes a difference and causes some fellers ter set up and take notice.

This is how it came about: Ther other day while loafin' around a hotel in Boston, Mass., a-wishin' it would stop rainin' so I could go out and rubber at ther tall buildin's, I picked up a copy of ther *Boston Post* and turned ter ther financial pages ter see how ther market was goin', although it didn't make a dinged mite of differences ter me one way or tother. About ther first thing I saw was, "Inventor Carroll Tests Engine." "Carroll!" says I ter myself and ther bell boy, "Dinged if that name don't sound familiar." And then I remembered that about three years ago POWER printed an article about Carroll and ther latest mechanical fake, ther CO_2 motor. "By Heck," says I, "it must be ther same feller." And I swore a vow about a yard long that I'd go up ter 304 Columbus avenue and see John, rain or shine, and I did.



FROM THER "DATO" JOHN HANDED OUT I DIDN'T QUITE CATCH THER FULL SIGNIFICANCE OF WHAT HE WAS TALKIN' ABOUT

Before startin' fer John's hangout I set down and read ther message he or someone else had published in ther *Post*. It said, as near as I can remember, that John had made such sweepin' claims as ter ther merits of ther CO_2 engine that most of ther visitors attendin' ther demonstration ther day before had gone up ter ther headquarters of ther Carbonic Engine and Power Company with misgivin's as ter ther safe use and successful control of ther gas John used. But ther way "fearless Carroll" monkeyed with this gas of great expansive power, and ther instant response of both gas and engine ter his slightest wish, soon disarmed all fears and drove all timidity out of ther demonstratin' room. Ther article don't say how ther spectators were affected.

Well, ter make a short story long, I hiked down ter ther subway and got a surface car fer ther place where John was explainin' things from ther "dato" he had picked up here and there.

Seein' I had on a clean collar and an overcoat what gave me ther appearance of a millionaire, I walked inter ther demonstratin' room just as if I owned most of ther town and intended ter buy out ther whole dinged issue of stock ther company had up fer sale.

It wasn't mor'n a minute before one of ther promoter fellers wanted ter know if I had come by appointment. I had ter tell ther truth and admit that I had not, but that I was interested in ther engine just ther same.

"Financial?" says he.

"Otherwise," says I.

Then ther feller said that only invited guests were expected ter witness ther doin's of Carroll, and so I told him I supposed I had ter get out.

He must have liked my looks, so ter speak, fer he said I could stay, which I did with a smile on my face like one sees on a feller who is ridin' on an old transfer or gettin' rid of a bad nickel.

One of ther fellers doin' ther talkin' got mixed up several times when some inquisitive cuss wanted ter know how ther gas was liquefied after doin' work in ther engine, and he had ter admit that he didn't know, and I began ter wonder what he was there fer. Later on, one of ther fellers told me confidential like that ther object of ther demonstration was ter get fellers interested so as ter exchange their cash fer stock.

As soon as John began ter talk "dato" (in English "dato" means data) ther door leadin' ter ther street was locked. If a feller came along and tried ter get in, it all depended on how he was dressed whether ther door swung open ter welcome him or not. I don't know why they were so mighty partickler, unless it was because John was afraid some of ther POWER fellers might come in and ask embarrassin' questions.

The "dato" John gave us didn't amount ter much; in fact, I don't know when I have heard so much "dato" with nothin' in it. Ther reason John didn't go inter details about a good many points was because, as he said, it would take a dinged long time ter go inter things, and even then we wouldn't understand 'um.

There were three engines in ther room; one was on an automobile frame, another settin' over ter one side of ther room, and a third on a truck, which I concluded, from its general appearance, was ther same engine John had in Philadelphia about three years ago when ther editor of POWER called it "Another Demonstration of Gettin' Somethin' fer Nothin'" at "Only $25 a share fer stock of a clumsy trick." The new company, by ther way, will sell 500,000 shares of stock, ther par value bein' $10 per share, ter any feller who's got ther cash ter put up fer 'um.

Carroll didn't run ther big engine much, or any of 'um fer that matter, as he said he had it there ter just tinker with, but he did set ther thing goin' just ter show it would run. John said that ther gas in ther expansion tank was allowed ter absorb heat from ther atmosphere, which caused ther gas ter expand and after passin' through ther engin' cylinder, ther gas was caught in a regeneratin' or exhaust tank. In ther exhaust tank ther temperature was reduced and ther gas reliquefied by passin' through a series of inner tanks between which "are vacuums." He didn't say how many vacuums there were. Then ther gas goes back ter ther chargin' tank and is ready fer another circuit, so John said.

I asked John what ther vacuum had ter do with it, but from ther "dato" he handed out I didn't quite catch ther full

significance of what he was talkin' about. I don't think anyone else did either.

I suppose it must be all right if John E. Carroll says so, and if he don't know, who does? Just ther same, if John would simplify his "dato" when he gets ter lecturin' and say somethin' ter ther point, things might look different ter a lot of fellers who don't know carbonic-acid gas from cod-liver oil.

John worked ther automobile truck across ther room a couple of times and then let ther engine run uncoupled a mite, and no one seemed ter get on ter ther racket that ther tank could contain enough compressed carbonic gas ter run ther engine fer ther little time John was on ther job. I don't say such was ther case, and I didn't then, fer I wanted ter stay and see all ther was ter be seen. John's "dato" didn't touch on this point either. As ter silencin' ther exhaust of ther engine I kinder got an idea that an exhaust muffler of some kind, concealed in ther exhaust-gas tank, would do ther trick.

Before I left I got a copy of ther prospectus issued by ther company, but it don't say much that would appeal ter a mechanical man. It says in one place that ther exact character of ther methods by which ther industry based on ther invention is ter be developed is of minor importance, and that because ther carbonic engine will so far surpass all known powers and engin's in economy ther company could make a success even though ther business end were carried on with extravagance and waste.—It looks as if somethin' was goin' ter be done with ther cash.

Ther prospectus goes on ter state that if John is willin' ter intrust inter ther hands of ther company this child of his brain—this nurslin' of his boyhood—this offspring of his labor—it would seem that ther public might well intrust in ther same hands ther custody and wise use of their investment. * * * * They appeal ter public investors, both large and small, for money, which is ter be ther yeast ter leaven ther loaf of a great business success, and they pledge to 'um ther most serious effort, their determined energy, and ter ther best of their ability see ter it that ther division of that loaf may provide a generous sustenance fer ther investors and their posterity.

When I got through readin' that I didn't know whether I was up against an orphan asylum or a bakery. I thought I heard someone say "slush," but I calculate it was imagination.

John is likened to a "doubting Thomas." He didn't believe in ther idea of expandin' carbonic gas fer power purposes, at first, any more than I do now, after seein' ther dinged engine run. John had ter be shown, and after years of labor, filled with days of discouragement and interposed only at long intervals by an added element of success, John at last got ther gas problem down with both shoulders on ther mat. John, by ther way, don't look as if he had given away to hopeless despair, so things must be comin' his way.

Ther last paragraph of ther prospectus deals with dividends and says that ther company does not feel that one can make a mistake in investin' as much as one can afford in stock of ther Carbonic Engine and Power Company.

Perhaps not, but I ain't agoin' ter buy any at $10 a share, when I can get all ther gold minin' stock I want fer 10 cents a share, and that's ther investment fer me, by Heck, when I can't find any other way ter get rid of what money I have to spare.

Early History of Stokers in England

By J. F. Springer

Automatic stokers date back to 1819 when William Brunton invented a rotating circular grate. In 1822 he patented a moving grate which contained an idea fundamental to the modern overfeed stoker. John Juckes developed the underfeed idea in 1838 and 1839. In 1841 he built the first chain grate.

In 1785 James Watt obtained a British patent for a furnace whose fundamental idea is still retained in certain of the most modern of our stoking machines. By referring to Fig. 1, one of his arrangements will be seen in longitudinal, vertical section. The fuel magazine is located at *G H*. The fuel rests on a dead plate *L*. At *E* is the ashpit. To the left is the chimney. There are one or more flue connections between the pile of fuel and the chimney. A portion of the connecting flues is the body of the furnace. There is a door at *F* opening into the ashpit. At *I* is an opening connecting the base of the fuel pile with the external air. When it is desired to begin operations, a small body of fuel is used to start a fire on *L*, the space *G H* is empty. The fire having been started, fuel is gradually added until the fuel magazine is filled, care being taken, meanwhile, to prevent closure of the connection with the external air up through the body of the magazine. This may be accomplished by keeping the body of the fuel in a loose condition, or by preventing it from packing against the front wall *N*. The object of Watt's invention is stated in his specifications as follows: "My said newly improved methods of constructing furnaces or fireplaces consist in causing the smoak or flame of the fresh fuel in its way to the flues or chimney to pass together with a current of fresh air through, over or among fuel which has already ceased to smoke, or which is converted into coaks, charcoal or cinders, and which is intensely hot, by which means the smoak and grosser parts of the flame, by coming into close contact with or by being brought near unto the said intensely hot fuel, and by being mixed with the current of fresh or unburnt air, are consumed or converted into heat, or into pure flame, free from smoak."

It will be gathered from this that James Watt had conceived the idea of progressively coking the fuel after being fed into the magazine at *G*. The bed of live coals is located at the base of the fuel magazine. Oxygen comes in from above and through the aperture *I*. The heat of this bed of coals would, of course, affect the fresh fuel above. The "smoak" which is distilled as a result would be carried by the air current downward and would find an outlet at *D*. Fresh air coming in at *I* would mingle with this smoke-laden current at the moment when it reached the bed of "intensely hot" coals. Combustion of the "smoak" would follow.

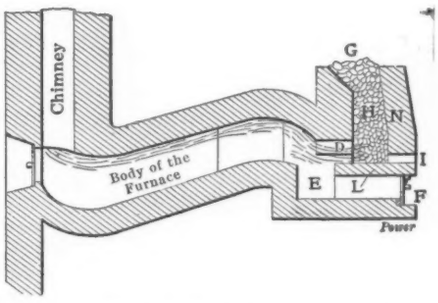


FIG. 1. WATT'S SMOKELESS FURNACE

C. Wye Williams, more than half a century subsequent to Watt, claimed, in his "Prize Essay on the Prevention of the Smoke Nuisance," that Watt was in error in supposing that it was necessary

to pass the volatile emanations from the heated fuel through the incandescent body of coals. He contended that this was not essential to combustion. If the necessary materials are present, then all that is essential is that combustion be started. Continuous ignition would then

FIG. 2. THE DOWSON & HAWKINS UNDERFEED STOKER

follow, the heat set free by the combustion of one cluster of particles serving to ignite adjacent clusters. Williams pointed out, further, that a supply of fresh air was an essential. In other words, he found, in effect, that Watt was right in admitting fresh air at *I*, as more oxygen was needed to consume the "smoak"; but wrong in supposing it necessary to pass this volatile matter through the incandescent body of fuel.

It will be observed that Watt provided no means for automatically feeding his fire or for maintaining the open space through the fuel magazine in a vertical direction. However, his arrangement does contain fundamental ideas which are valued today.

In 1816 a British patent was issued to Dowson & Hawkins. Their device may be described as a stoking instrument, although it is not automatic. Similar to that of Watt's, this patent involved fundamental conceptions which are made use of today in certain of the successful stoking machines. In Fig. 2 is shown, in longitudinal section, a view of one form

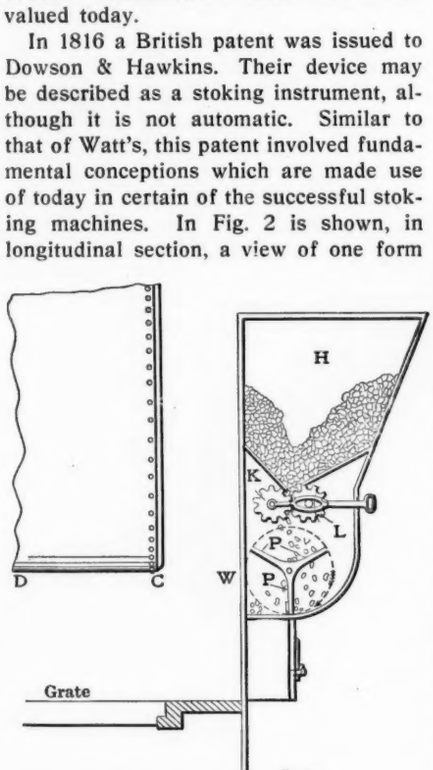


FIG. 3. STANLEY'S STOKER

of apparatus, drawn to accord with the patentees' specifications. At *A B* is the covered pan of a shovel. At *B* is hinged a door *F* which closes the outer end of the box-like pan. At the other end of the pan is a tube or hollow handle *C*, within which the rod *D* may be pushed back and forth. At one end of this rod is a handle, while at the opposite end is a piston *E*. It will be seen that if the pan is filled with coal or similar material, this fuel may be pushed out at the outer end by operating the piston rod. The door *F* becomes a valve, permitting coal to be ejected but not permitting the entrance of any of the granular or solid material into which the pan may be thrust.

The grate of the stove or furnace, where this stoking appliance is to be used, is provided with a plate, hinged beneath the grate so as to drop into the ashpit or arranged in such way that it may be slid away. When it is desired to introduce fresh fuel, this plate is brought into position beneath the grate. The pan, filled with coal, and having its door, or valve *F*, closed, is now thrust in just above the grate and underneath the existing body of live coals. By withdrawing the pan and suitably manipulating the rod *D*, the

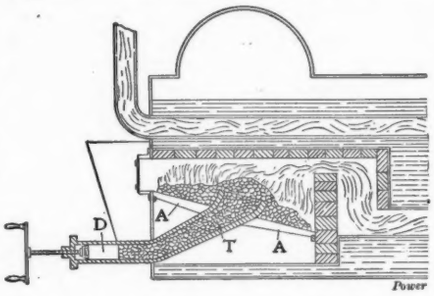


FIG. 4. JUCKES' UNDERFEED STOKER OF 1838

fresh coal will be deposited on the grate underneath the incandescent body of fuel. This device of Dowson & Hawkins was, perhaps, the first underfeed stoker.

William Brunton in 1819 obtained a British patent for a method of automatically feeding a furnace fire. This, perhaps, may be regarded as the first of the automatic stokers. It consisted of a circular, horizontal grate supported by a rotating vertical shaft. Above, in the roof of the furnace, was a long slot through which the fuel was dropped upon the rotating fire below. This slot was so placed and dimensioned that its discharge fed the fire radially. The fuel was agitated, apparently, for the purpose of causing the feeding to proceed with regularity and preventing choking. Brunton directed that a vertical drum be attached to and arranged below the rotating grate. This was to be cylindrical, of course. At the outer edge of the grate, and beginning somewhat below its surface, Brunton arranged a wall of firebrick, which rose about 6 inches above the grate. Beyond, there was an annular space between the entire rotating arrangement and the wall of the furnace, 1½ inches wide, radially. Below, and attached to the grate, was a cylindrical drum of sheet iron. The lower end of this drum rotated in a body of sand. The object of this arrangement was, apparently, to prevent the passage of any gases or the like from below the fire into the annular space between the rotating grate and the furnace wall. It seems to have been Brunton's idea to provide an independent, fresh supply of air which should rise through this annular space and assist in the combustion of the smoke rising from the top of the fire.

His apparatus appears to have met with some success. In the very year in which he received his patent, he testified before a committee of the House of Commons that such a furnace had been successfully operated as respects smoke consumption, in connection with a 20-horsepower engine at the Eagle foundry, Birmingham, and that it was expected to apply this style of furnace in connection with one of the largest engine installations in Cornwall for economical reasons and quite apart from any purpose of consuming smoke. Brunton was criticized by Mr. Williams in the essay already referred to because of his statement that he so fed the coal that the smoke evolved was compelled to pass over that part of the grate where the fuel was already in a condition of complete combustion. The inventor had in mind, no doubt, an arrangement of the feeding slot forward and of the bridge to the rear whereby the gases or smoke arising from the fresh fuel would be conducted over more or less of the circular surface of the fire. At present, we may scarcely agree with Mr. Williams that this is unnecessary and that it is only necessary to supply a sufficient quantity of oxygen. Whatever success Brunton attained was due largely, no doubt, to the supply, at the outer rim of the fire, of an amount of fresh oxygen at a moment when carbon monoxide and particles of carbon were being carried off by the draft.

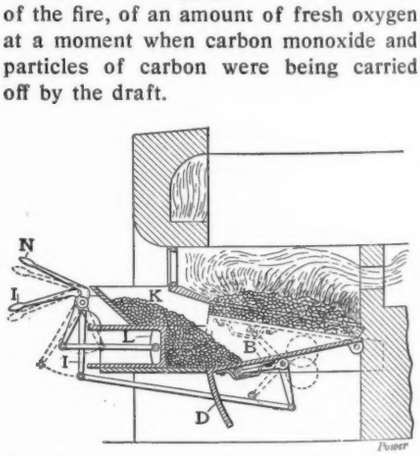


FIG. 5. JUCKES' UNDERFEED STOKER OF 1839

This same inventor, not content with merely giving the world his rotating grate, received in 1822 a patent for a mechanical stoking apparatus, the essentials of which remain in the form of one of the modern, overfeed stokers. In one of Brunton's devices, he provides a series of long bars parallel to each

other and to the direction in which the fuel is to be moved. The bars lie close together at the front of the furnace and thus form a dead plate. Then for a greater or lesser distance, they are individually narrowed so as to form a grate. Finally, the bars are broadened again to form a surface for clinkers and other incombustible material. Mechanism is provided whereby alternate rows of bars are raised as a unit and made to recede a short distance toward the rear of the furnace. They then sink below the original surface and while so depressed are returned to their initial position. Fresh fuel is fed onto the dead plate, the active fire lies over the open grate, and the unconsumed material finds its way to the clinker plate. When the unified alternate bars are lifted and moved longitudinally, they carry rearward with them the fresh fuel, the burning fire, and the unconsumed material which has not fallen through the open bars to the ashpit below. This movement has served to cause a recession of each section of the material lying upon the bars toward the rear. The fresh fuel, farthest removed from the fire, is caused to pass to a hotter position; that nearer to the fire and more or less coked is moved to a still nearer position while some of it passes onto the open grate. In short, every section is made to recede a little with every movement of the bars. Even the clinkers at the extreme end are dropped off into a receptacle provided for the purpose.

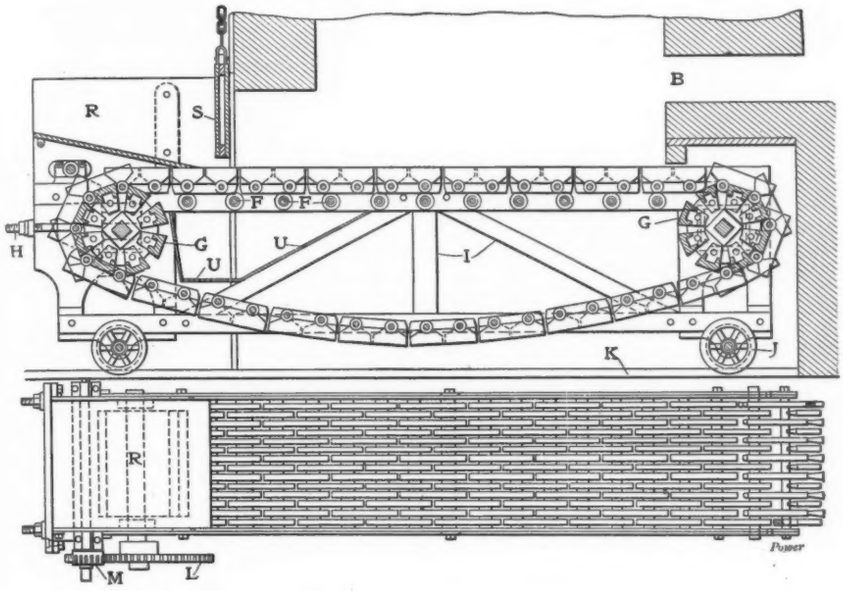


FIG. 6. JUCKES' CHAIN-GRATE STOKER OF 1841

In one design, Brunton provided for a double action by having both alternate set of bars move as units. While one set rose and receded, the other set sank and advanced, producing the result already described.

He also devised another construction, in which the bars were inclined toward the rear of the furnace. They could then, having the assistance of gravitation, be manipulated in various ways and, thus, the backward movement of the fire was accomplished. He even arranged a fixed surface at the rear with which the bars were always in contact and upon which the movable ones had a sliding motion while their front ends were raised above the general surface and caused to recede.

That these devices of early invention contained ideas which were correct is made evident by the fact that many of their features survive in the present-day stokers.

During the same year, 1822, John Stanley received a British patent for a stoker which introduced the fuel by a flipping action. The operation of this apparatus, which was a coal crusher as well as a stoker, may be understood by referring to Fig. 3. The bottom of hopper *H* is formed by two inclined planes, one of which falls short of the line of intersection. By this means a long, transverse opening is left through which the coal falls from the hopper between two fluted rollers *K* and *L* which are suitably arranged and rotated to crush and remove the pieces of coal coming from the hopper. Below these crushing rollers is arranged an impeller which consists of a number of vanes *P* mounted upon a horizontal axis. By rapidly rotating this impeller from left to right as indicated, the small pieces of coal coming from the crusher are projected over the surface of the fire beneath the boiler *C D*.

Twelve years later, in 1834, this same inventor, in conjunction with one John Walmsley, obtained a British patent for a device in which the idea of projecting small quantities of coal over the surface of the fire was still retained, but the mechanical means of carrying this out were changed. In the patent of 1822 there was a long, transverse impeller rotating steadily in one direction. In the later device, the impeller consists of a number of blades set as spokes in a wheel which operates on a vertical axis. Further, instead of the rotation of the blades being continuous and in one direction, a reciprocating rotary motion is imparted whereby the blades swing first in one direction and then in the other. The form of the crushing rollers was also changed. Instead of having longitudinal flutings, the surface was covered with pyramid-like protuberances. There was, also, a method of oscillating the grate bars which were arranged transversely.

The idea of projecting small quantities of finely crushed fuel over the surface of the fire seems to have been a successful one, for in the late fifties we find Mr. Williams referring to the Stanley stoker as having come into extensive use.

The appearance of the fire in a furnace stoked with one of these machines is described as resembling a bed of crocus flowers. Many jets of flame can be seen dotting the surface and rising vertically from it. There was supplied a thin coating of fuel for which there was an adequate supply of air evenly distributed. This would seem to be the explanation of the success of this apparatus.

The British patents of John Juckes demand our attention for they show how closely he approached, for example, the underfeed idea which is now being applied so extensively. Thus, in his patent of 1838, Juckes discloses the device shown in Fig. 4. The fuel is introduced by means of the flaring tube *T* which projects into the bed of live coals. The

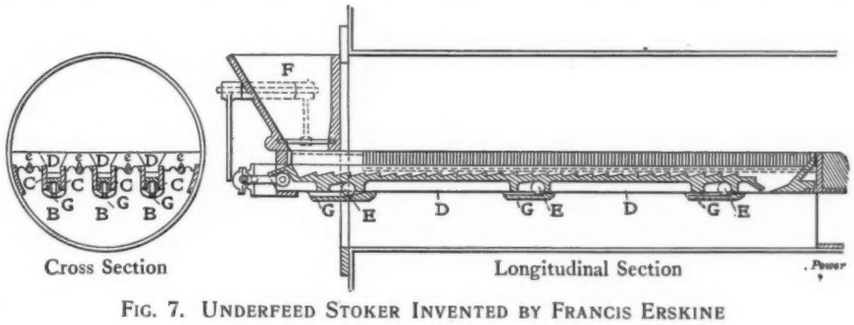


FIG. 7. UNDERFEED STOKER INVENTED BY FRANCIS ERSKINE

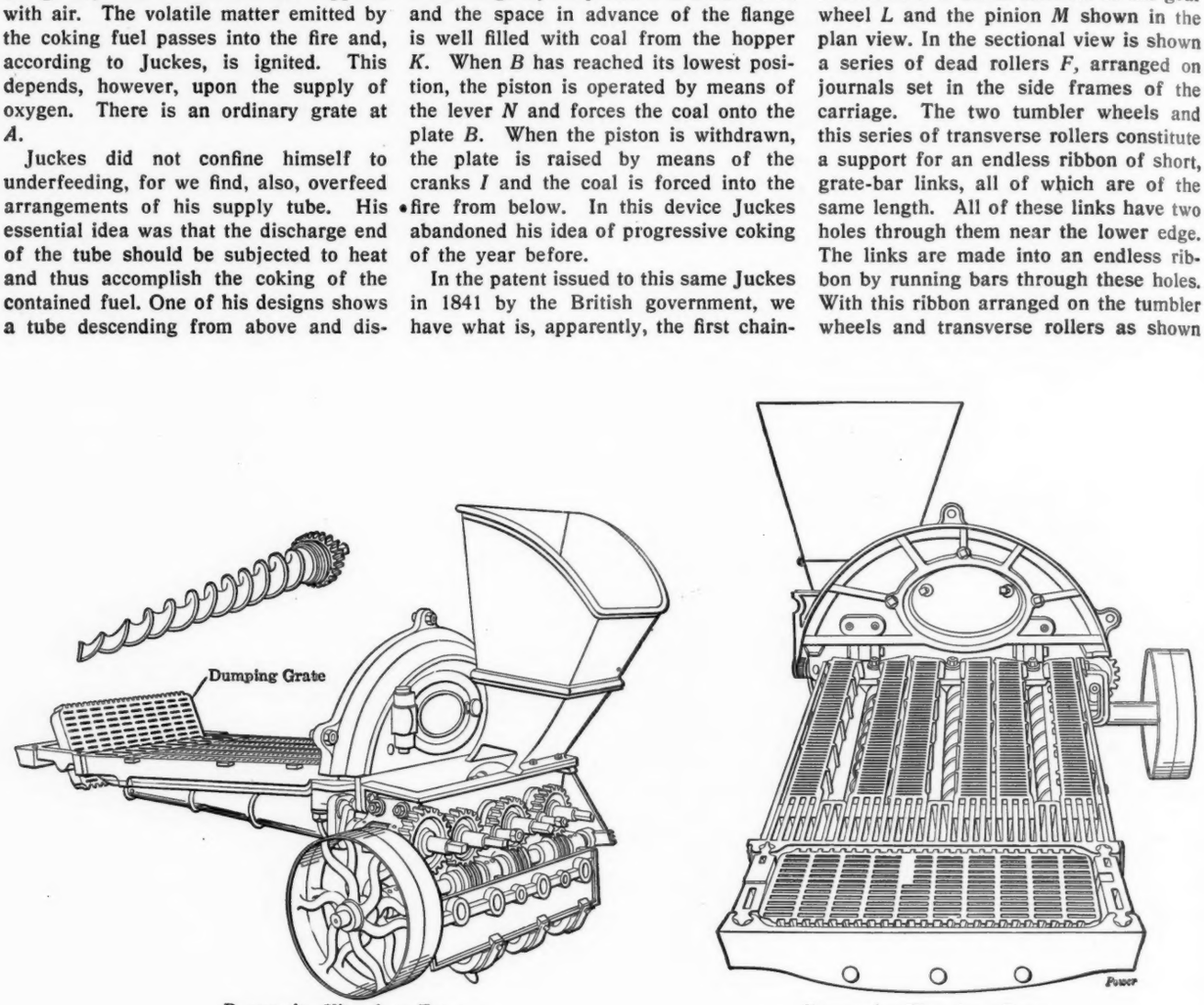
fuel is forced into place by means of the piston *D* operated by a screw and two-armed crank. The fuel in the mouth of the tube undergoes a coking operation, being subjected to heat but not supplied with air. The volatile matter emitted by the coking fuel passes into the fire and, according to Juckes, is ignited. This depends, however, upon the supply of oxygen. There is an ordinary grate at *A*.

Juckes did not confine himself to underfeeding, for we find, also, overfeed arrangements of his supply tube. His essential idea was that the discharge end of the tube should be subjected to heat and thus accomplish the coking of the contained fuel. One of his designs shows a tube descending from above and discharging onto the top of the fire a short distance from the center. Another shows the tube above the fire and arranged horizontally. This tube was exposed to the heat of the fire, particularly at its discharge end.

Perhaps the underfeed idea which was disclosed in the patent of 1838 suggested what was presented in his patent of 1839, which covered an underfeed stoker pure and simple. In Fig. 5 is shown a longitudinal section through the apparatus. This stoker does not extend the full width of the furnace but occupies a central position. There is thus a central longitudinal opening left in the grate. The plate *B* ordinarily closes this opening. When, however, it is desired to introduce fuel, this plate is lowered from the position shown by the dotted lines to that shown by the full ones. The bed of coals will, according to Juckes, for the most part, bridge the opening during the short absence of the supporting plate. Previous to lowering this plate, with its front flange *D*, the piston *L* is drawn back and the space in advance of the flange is well filled with coal from the hopper *K*. When *B* has reached its lowest position, the piston is operated by means of the lever *N* and forces the coal onto the plate *B*. When the piston is withdrawn, the plate is raised by means of the cranks *I* and the coal is forced into the fire from below. In this device Juckes abandoned his idea of progressive coking of the year before.

In the patent issued to this same Juckes in 1841 by the British government, we have what is, apparently, the first chain-grate stoker. It will be remembered that Brunton's device of 1822 provided for a continued recession of the fresh fuel, fire and mass of clinkers into the furnace. While there was thus a continuous movement of the body of material in one direction, the bars accomplishing it did not themselves have a continuous motion in one direction. They shifted back and forth. The idea of moving on and on the entire body of material, *en masse*, seems to have been an impressive one, for it is exactly what Juckes now proposed and exactly what is done in some of the most successful of modern stokers. In Fig. 6, at the top, we have a longitudinal, vertical section of Juckes' device of 1841. The opening into the flue is at *B*. Upon the track *K* rest the wheels *J* which support the frame *I*. There are two tumbler wheels *G* mounted upon axles arranged in this frame. The position of the forward tumbler wheel may be shifted backward or forward by means of the screws and nuts at *H*. The mechanism to actuate this wheel consists of the gear wheel *L* and the pinion *M* shown in the plan view. In the sectional view is shown a series of dead rollers *F*, arranged on journals set in the side frames of the carriage. The two tumbler wheels and this series of transverse rollers constitute a support for an endless ribbon of short, grate-bar links, all of which are of the same length. All of these links have two holes through them near the lower edge. The links are made into an endless ribbon by running bars through these holes. With this ribbon arranged on the tumbler wheels and transverse rollers as shown in the plan view, we have the main features of the chain-grate stoker mechanism. The fuel is fed in by means of the hopper *R*. The rate of feed is regulated by the door *S*, adjustable vertically. Juckes assigned a yard per hour as an advantageous rate of movement of his chain grate. He remarks that fine coal can be burned to advantage by this device. Further, he says that the device has an advantage in that the grate bars are not continuously exposed to intense heat. The entire stoker may be withdrawn from the furnace for repairs or other purposes. The pan *U* is for the purpose of catching whatever fine coal falls between the grate bars before sufficient time has elapsed for its ignition.

In the seventies of the last century, two British inventors occupied themselves with the underfeed idea, and in 1876, a



Perspective View from Front. Perspective View from Rear.

FIG. 8. THE UNDERFEED STOKER EXHIBITED AT PARIS

patent was issued to Francis Erskine which discloses two different types of feeding mechanism.

In one of these, Fig. 7, the hopper is located at *F*. This communicates with a longitudinal trough extending the length of the furnace. A series of these troughs are arranged parallel to one another as at *B* in the cross-section. Between the side walls *C* of the troughs lie long bars *D* having saw teeth above and being suitably formed beneath to coöperate with the transverse rollers *E* which bear on the parts *G*. Mechanism is provided at the front to give to the toothed bars a reciprocating motion in their troughs and on their rollers. The parts *G*, on which the rollers ride, are inclined so that the reciprocating movement is accompanied by an elevating motion of the toothed bars. The fuel, which enters from the hopper, is thus propelled and lifted. At their extreme inner ends, the bars were specially formed to coöperate with the end of the trough in securing the ejection of the fuel at that point. Air is supplied through the grates connecting the longitudinal troughs.

In an alternative construction, disclosed in the same patent, Erskine makes use of a tapered screw instead of the toothed bar. The same idea of a series of screws being used to supply the actual stoking movement is shown in an American patent granted in 1878 to the other of the British inventors to whom reference is being made. This device was shown at the Paris Exhibition with some minor alterations. The general arrangement is shown in Fig. 8. The coal was fed in through a hopper which was located to one side of the furnace door. The fuel passed into a transverse trough along the length of which it was distributed by means of a worm or screw. Three longitudinal troughs communicated with this transverse one. These three troughs, together with the grate bars connecting them, formed the floor for the fire. Within the longitudinal troughs, tapering screws were placed. The shanks of these screws projected in front and were fitted with gear wheels. The gears were rotated by a transverse worm actuated by a pulley at one end. A fourth gear meshed with the external one and thus actuated, in turn, mechanism which reciprocated the grate surfaces slowly in a longitudinal direction. In the American patent, the grate surface and the axis of the longitudinal screw are both shown as inclined down toward the rear of the furnace. A dumping grate at the rear can be tilted by means of a rod projecting in front, as may be seen in the perspective views.

Explosion Due to Blowoff Valve

By W. E. Losie

A rupture in the shell of a return tubular boiler, caused by the blowing out of an asbestos-packed blowoff cock, emptied the boiler of water and permitted overheating to take place.

The necessity of having all boiler fittings placed so as to facilitate thorough and independent inspection was emphasized by an explosion which recently occurred at the works of the Vancouver Portland Cement Company, Tod Inlet, B. C.

The plant includes a battery of eight boilers of the return-tubular type, 72 inches in diameter and with plates 9/16 inch thick. They had been subjected to a hydraulic test of 200 pounds per square inch and were operating regularly under a steam pressure of 130 pounds, at which they were being somewhat forced to supply steam for engines of 1300 horsepower.

At the time of the accident, the greater part of the load had been off for about ten minutes. The water tender had looked over the gage glasses as soon as the power was shut off and reported the glasses to be three-quarters full in each of the eight boilers. He had barely returned from this inspection, when a roaring noise was heard and the boiler room became enveloped in steam. Accompanied by the engineer he groped his way to the end of the boiler room and closed the valves from the three end boilers, not knowing which of these had caused the trouble as they were all connected to one header.

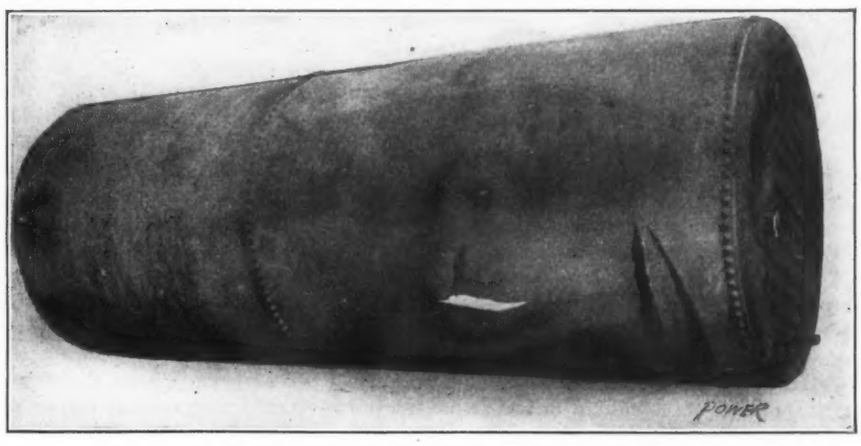
When the steam had cleared away an examination was made and revealed a rupture 21 inches long and 4 inches wide in the lower right-hand section of No. 8 boiler. A photograph of the boiler is shown in the accompanying illustration, in which the outlines of the hole are clearly brought out by a white sack having been placed inside the boiler. It may be seen that the shell was considerably distended and at the point of rupture had bagged until the metal was only ⅛ inch thick.

Following this preliminary inspection, a boiler inspector was sent for and upon his arrival he ordered all fittings removed and proceeded to make a thorough examination. He then reported the accident to be due to gross carelessness on the part of the attendants.

Knowing the attendants to be thoroughly capable and reliable, the superintendent refused to accept this decision and insisted upon an investigation by the chief boiler inspector for that district. In the meantime permission was obtained to remove the boiler to make way for a new one, and in removing the blowoff fittings the cause of the accident was discovered. The blowoff cock, which was connected to a common header for all the boilers, had failed. It was of the asbestos-packed type and a section ¼x4 inches had blown out, thus allowing the water in the boiler to escape in a very few minutes, the result being, of course, overheating and consequent rupture of the shell.

No time was lost in removing the remainder of the asbestos-packed valves on the other boilers and replacing them with others of a type that can be readily examined when the boiler is cleaned. At the same time each valve was arranged to blow into a separate open tank where any escape could be detected.

It was exceedingly fortunate that no damage resulted other than that to the boiler and some surrounding brickwork.



HOLE IN BOILER SHOWN BY WHITE PORTION

Electrical Department

The Electric Elevator

By William Baxter, Jr.

Eastern System with Semi-electric Control

The controller shown in Fig. 107 is much more elaborate than those in Figs. 103 and 105, and is the type generally used with the Eastern Company's elevators. It is one of the Cutler-Hammer designs, and is known as a "clapper-switch" controller. The actual appearance is more fully shown in Fig. 109. The reversing switch *R*, on top of the controller, is the same as that used in

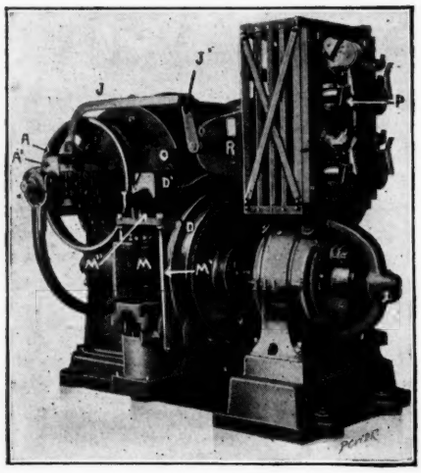


Fig. 107. Outfit with Magnet-operated Brake

the controller of Fig. 103. Of the four electromagnetic switches on the front of the panel in Fig. 109, No. 1 is the main line switch and the other three are for the purpose of cutting out the starting resistance. In the controller of Fig. 105 there is a large number of contacts for the switch arm to travel over in cutting out the starting resistance, so that the latter is removed from the armature circuit by small degrees. In Fig. 109 there are only three switches to cut out the resistance, and from this it might be inferred that each time a switch is closed there is a decided jump in the motor speed, but that is not the case; in fact, there are controllers made in which the starting resistance is cut out in two steps and even with these there is no unpleasant jumping in speed.

The use of a few separate magnetic switches to cut out the starting resistance is generally considered the most desirable arrangement because there is less danger of the switches getting out of order than there is with the construction of Fig. 105. With the latter arrangement it is possible

Especially conducted to be of interest and service to the men in charge of the electrical equipment.

for the contacts to become so rough as to cause the switch lever to stick and fail to cut out all the resistance when starting up, or to cut in all of it when the elevator is stopped. With the individual switches, the contacts, even if they become badly burned, will not stick and the resistance is sure to be cut out.

In Fig. 109 the main-line switch 1 is actuated by a magnet *D*, and the circuit of this is controlled by contacts in the reversing switch *R*. When the motor is started, the first movement of the drum of the switch *R* makes all the necessary connections of the motor circuits so that current may flow through them in the proper direction for the desired direction of movement of the elevator, and immediately afterward closes the circuit of the main-line switch magnet *D*. The three resistance switches, 2, 3 and 4, are interlocked with the main switch in such a way that the latter cannot be closed except when all the other switches are open and these other switches cannot be closed except in the order in which they are marked; that is, No. 3 cannot close until Nos. 1 and 2 are closed, and No. 4 will not close until after No. 3 has closed. Furthermore, the switches are made so that neither one of the resistance switches can close unless the current flowing through the armature is below the strength for which the master switches are adjusted. The small master switch magnet at *h''* controls the flow of current through the magnet of the switch 2, and unless the current flowing through the motor armature circuit is sufficiently low the circuit of the magnet *E* of which the switch 2 will not be closed. In like manner, the small master switch magnet *k* at the side of the switch 2 controls the circuit of the magnet *F* of the switch 3 and prevents this switch from acting until the motor armature current has dropped to the proper strength. The switch magnet *l* controls the circuit of the magnet *G* of the switch 4 in the same way. This arrangement prevents cutting out the starting resistance so rapidly as to cause the armature current to rise to a dangerous strength.

In the controller of Fig. 105 the rate at which the starting resistance is cut out is controlled by the action of the dashpot *D*, and this can be adjusted so as to permit the switch lever to swing over the contacts as slowly as necessary. In the controller of Fig. 109 the rapidity with which the starting resistance is cut out is controlled entirely by the strength of the current flowing through the armature of the motor. The operation of this controller can be more fully understood by studying the wiring diagram, which is shown in Fig. 110. At the upper part are shown the contacts of the reversing switch *R*, the long contacts *A'* and *B'* being mounted on the drum and the small squares representing stationary fingers that rub against the drum contacts.

The contact *S W* is connected with one end of the coil of the magnet *D* of the switch 1, the other end of this magnet coil being connected directly with the positive line wire. When the reversing switch is moved in either direction, the contact plates *A'* and *B'* on the drum come in contact with some of the stationary contacts shown in vertical rows on either side of *A'*. The contacts *A'* and *B'* connect first so as to make the proper circuit connections for the motor before

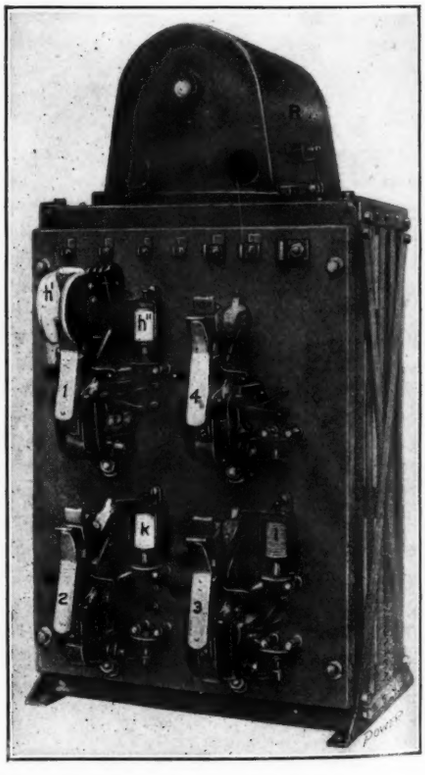


Fig. 109. Controller with Interlocked Automatic Accelerating Magnet Switches

the current is flowing through them, and immediately thereafter, one or the other of the short contacts Z, Z', connect with $S\,W$, and thus close the circuit of the magnet D of the switch 1. If the three switches 2, 3 and 4 are closed, the small switches marked S will also be closed, and then the current coming from the positive line wire will be able to pass through these switches and reach the magnet D without having to pass through the resistance K. When the current can flow through this path it is strong enough to cause the magnet D to close the main switch; but if any one of the switches 2, 3 or 4 is open, the current will have to pass through the resistance K and it will be so weakened that the magnet D will not be able to close the main switch.

When the main switch is closed, the current that flows through the armature motor will also flow through the magnet h'', and if it is above the maximum allowable strength, this magnet will be strong enough to hold up its armature, opening the switch contacts $S\,S$ below it, and no current will flow through the magnet of the switch 2. Then the current drops to the proper strength, the magnet h'' will be unable to hold up the plunger, and when the latter drops the switch contacts $S\,S$ will be closed, allowing the magnet of the switch 2 to be energized, and the first section, $R1$, of the starting resistance will be cut out by the closing of the switch 2. As soon as this resistance is cut out the motor current will once more increase in strength and the magnet K will pull up its plunger and keep the circuit of the magnet of the switch 3 open until the motor current drops to the proper strength. In the same way the magnet l will control the flow of current through the circuit of the magnet of the switch 4.

The diagram, Fig. 110, is rather complicated owing to the fact that the switches are shown in the position they actually occupy on the controller panel, as may be seen by comparing it with Fig. 109. The actual path of the currents through all the wires of the system can be easily traced out in the simplified diagram, Fig. 111, in which the position of the switches has been changed so as to make the wire connections more simple. The operation of the reversing switch can be understood by reference to the top view of this switch which is shown in the small sketch just above the main diagram. The circular part represents the rotating drum, with the contact segments A' on one side and B' on the other. The stationary contact fingers are shown at A and B. These contacts are arranged in the way shown in the front view of the reverser just below. If the drum is rotated clockwise, the segments A' will come in touch with the stationary contacts A, and segments B' will connect with the contacts B. In this diagram it will be evident that with the drum in this position, the segment x of the A' set will connect with an armature contact, and the segment y will connect with the negative line, while the segment z will connect with the contact $S\,W$. The segment v of the B' set will connect with the other armature terminal, and the segment y' will connect with the contact N, which is connected to the lower end N of the switch 4.

With the connections made as just described, the current from the positive line can pass through the magnet D of the switch 1 to the wire D', contact $S\,W$, segments z and y, and to the negative line. If the switches 2, 3 and 4 are all open, as shown, the three switches s will be closed, and then the current will be able to pass to the wire C'' and directly to the magnet D, without having to pass through the resistance K, and cause the magnet D to close the switch l, as previously described. With all of the switches s closed and switch l closed, the current will flow through the magnet h'' to the wire H', through the three sections of the starting resistance, through the series winding of the brake magnet and the series field winding of the motor to the contact N of the reversing switch; thence through the motor armature by way of the segments v and y', to the contacts B and A, and through the segments x and y to the negative line.

As soon as the armature current drops to the proper strength, the magnet h will let its plunger drop, closing the contacts $s\,s$, and the current will pass to the wire e and through the magnet E, which will close the switch 2 and cut out the section $R1$ of the starting resistance. This procedure is followed successively by the master magnet k and the switch magnet F, closing the switch 3, and the master magnet l and switch magnet G, closing the switch 4; when this switch is closed the third resistance section $R3$, the brake series coil, and the series field winding of the motor will be cut out. The circuit between the wires C' and C'' is opened as soon as the switch 2 is closed, but at this time the switch l is closed and the magnet D is strong enough to hold it closed, although it would not be able to close the switch if it were open.

The series winding of the brake magnet is made strong enough to lift the brake, so that it does not depend upon any help it may obtain from the shunt winding; the latter is intended to hold the brake up after the series winding has been cut out. The series field winding of the motor is only used in starting the motor, and is cut out as soon as the armature is up to full speed, so that while running at full speed the motor is a simple shunt-wound machine.

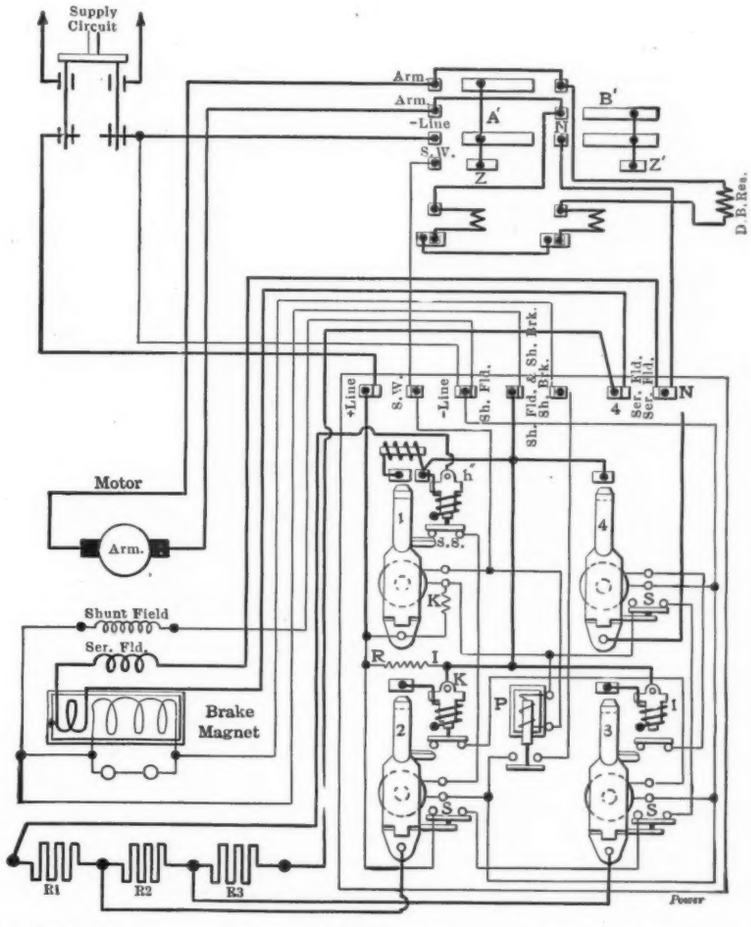


FIG. 110. DIAGRAM OF ACTUAL CONNECTIONS FOR CONTROLLER IN FIG. 109

In starting, as soon as the current reaches the wire *C"* it passes through the magnet coil *P*, which closes the circuit of the brake-magnet shunt winding. The reversing switch contacts at *w, w*, close a dynamic brake circuit when the reversing switch is turned to the "stop" position (in which it is drawn) and it will be noticed that with the reversing switch in this position the circuit through the shunt field winding of the motor is also closed, but through the resistance *T*. Thus at all times the motor shunt field is connected with the line, but when the motor is stopped the current is considerably reduced, because it has to pass through the resistance *T*. This constitutes the type of dynamic brake explained in a previous article in which the motor field is kept magnetized continuously by line current so that the counter e.m.f. may keep up even when the speed reduced below the velocity at which the motor would act as a generator when it furnishes its own field current.

The magnet-operated switch *P* is not always used; it is not shown in the illustration of the controller in Fig. 109, but is shown at *P* in Fig. 107. When it is not used, contacts for closing and opening the brake magnet circuit are put on the reversing switch.

It will be noticed that the main switch *l* is provided with a magnetic blow out; this is required because it is here that the main circuit is broken. The contacts of the reversing switch are not separated until after the circuit is broken at switch *l*, hence there is no sparking at this point, and this is also true of switches 2, 3 and 4; these do not open until after No. 1 opens and the current is cut off.

The Compounding of the Three-Wire Generator

By J. M. Row

In Mr. Williams' article on page 487 of the March 15 issue, giving an explanation of the three-wire generator, one feature which is very essential to the regulation of voltage was not mentioned. Of course, the ideal condition in the three-wire system would be a perfectly balanced load, under which condition the neutral wire back to the generator could be dispensed with; and any dynamo could be used for the generation of power for such a system. But unfortunately the ideal condition seldom exists in practice, and never for prolonged periods of time.

In Fig. 1, indicating a balanced load, sup-

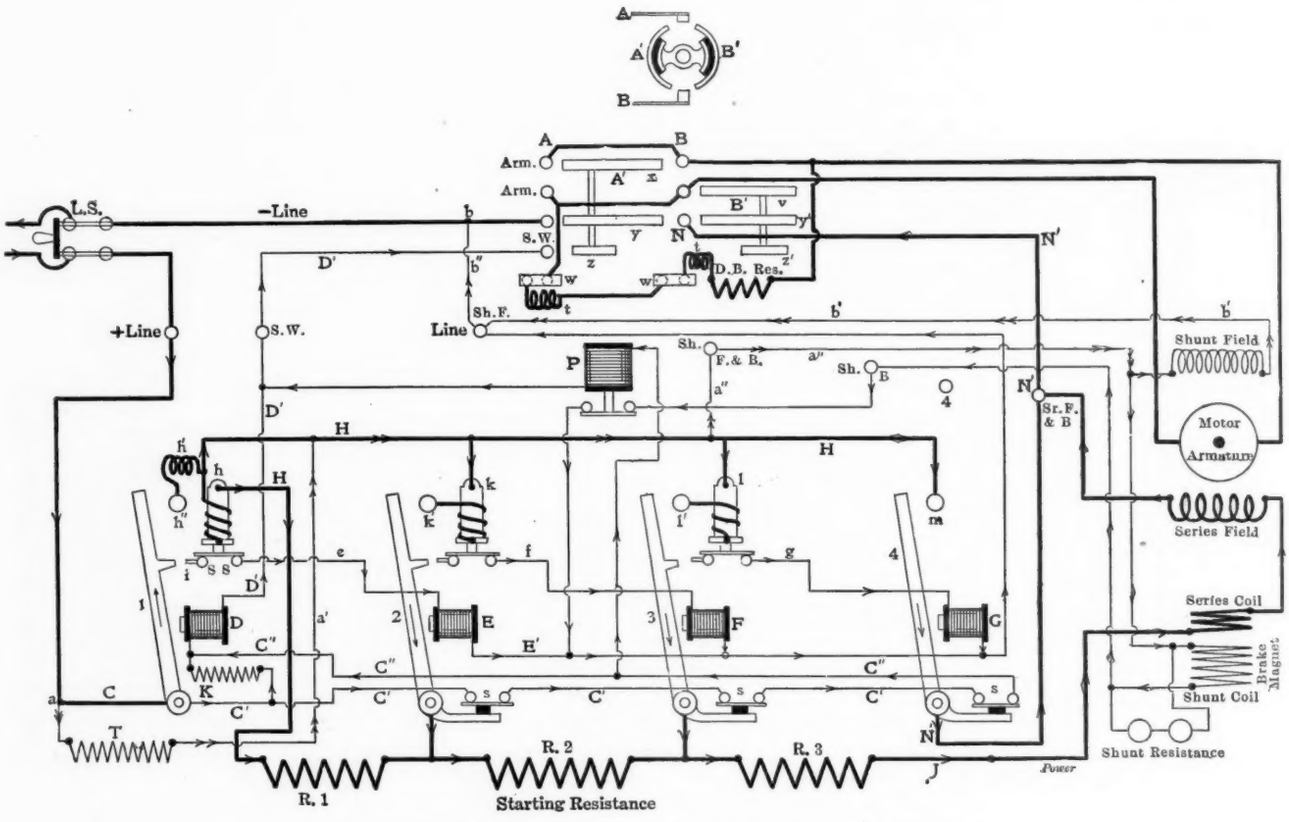


FIG. 111. SIMPLIFIED DIAGRAM OF CONNECTIONS AND APPARATUS

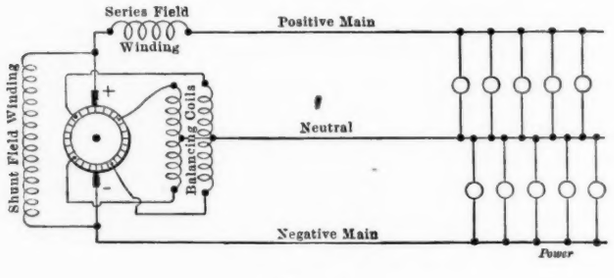


FIG. 1

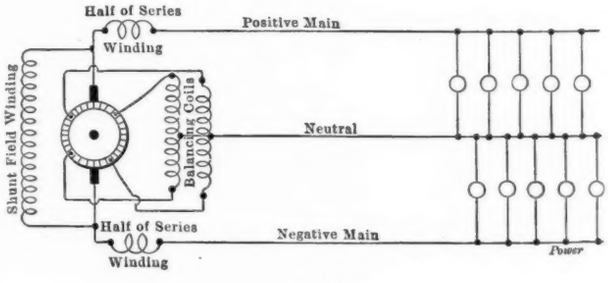


FIG. 2

pose sufficient lamps were connected from the neutral to the negative main to take an additional 100 amperes. As this 100 amperes flows through only half the armature winding, at most, it would produce no greater internal drop than 50 amperes would through the entire armature. But as the series field winding is connected in the positive lead of the generator, the increased current in the negative main cannot make the field any stronger, and the line voltage will be diminished just as much as it would if the generator had no series field winding and the load were increased by 50 amperes.

Now suppose that instead of being connected between the neutral and the negative main these additional lamps had been connected between the positive main and the neutral; then the internal drop would be the same as before. But the field would be strengthened by the series winding sufficiently to compensate for the

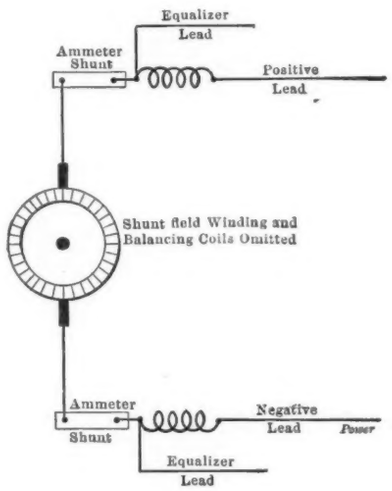


FIG. 3

internal drop which would be produced by 100 amperes through the entire armature; while in reality the internal drop would be not quite half that amount. Under this condition the line voltage would be just as much above normal as it would be below under the first condition. This, it is needless to say, would be very unsatisfactory.

The difficulty just outlined has been overcome by dividing the series field winding into two equal sections and connecting one of these sections in series with each main, as shown in Fig. 2. With this arrangement an increase of load in either division of the system—that is, on either side of the neutral—will strengthen the field enough to compensate for the increased armature drop. And in no way can the load be changed without a corresponding change in the field strength. Even with this arrangement, however, there is a small deficiency in the voltage regulation with unbalanced loads, due to the resistance of the balancing coils; this causes the side carrying the greater current to have a slightly lower voltage. This, however, is too small to affect the operation seriously under any conditions which would occur in good practice.

Where three-wire generators are to be paralleled they are provided with two equalizer leads, this being necessary because the series field winding is divided into two sections. And in order to have the ammeter readings include the current flowing through the equalizers, the ammeters are connected between the brushes and equalizer junctions instead of in one of the main leads beyond the generator terminals, as is the practice with two-wire generators. This is illustrated diagrammatically in Fig. 3.

LETTERS

Erratic Parallel Operation

In the plant where I am employed there are two stations, operated in parallel. In one there is a 1500-kilowatt generator driven by a steam turbine, and in the other are two 220-kilowatt machines driven by waterwheels and one 540-kilowatt generator belted from shafting driven by a 1500-horsepower cross-compound steam engine. All of the generators are 60-cycle three-phase machines delivering 600 volts.

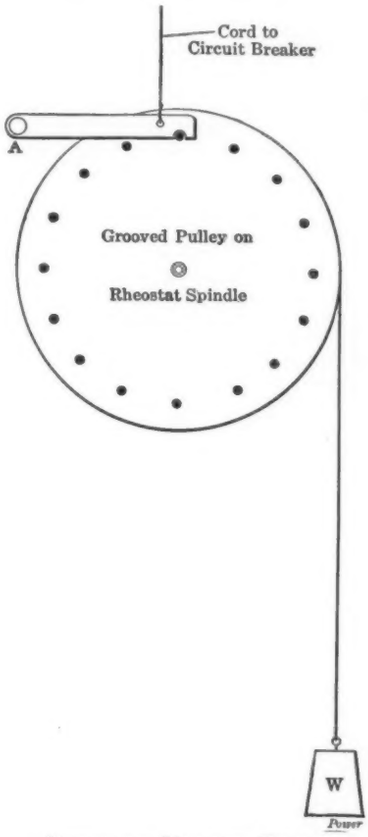
When the turbine set and the waterwheel sets are run together there seems to be no trouble; also if the 540-kilowatt belted generator and the waterwheel units are run together there seems to be no trouble; but if the turbine-driven machine and the belted machine are run together there is a heavy cross current.

There is a difference of opinion between the managers of the two stations regarding the cause of this cross current and I would like the opinion of some of the readers of POWER who have had experience in running alternators in parallel as to the cause of the cross current.

S. E. CHARLES.

Automatic Voltage Relief

Owing to excessive increase of speed when the circuit-breaker of a 200-kilowatt railway generator blew out (the engine governor not being able to correct the speed quickly enough), the voltage would run up and flash over. Numerous small holes began to develop in the commutator, and it became evident that something would have to be done to prevent it. The following expedient was tried, and has worked satisfactorily ever since. The handwheel was taken off the rheostat arm and a grooved pulley 8 inches in diameter was fitted in its place. In the rear face of the pulley small holes were drilled about 2 inches apart, and pins put in these to extend ½ inch from the face of the wheel. It was then put on, and a piece of flat iron 7 inches long and 1 inch wide was shaped as shown in the sketch. This was pivoted on a bolt at *A*, so that the notch cut in the edge near the other end would slip over any one of the pins. Then a cord was carried from the lever to the handle of the circuit breaker so that the lever would be lifted from the pin when the circuit breaker went out. Then a weight *W* was



AUTOMATIC VOLTAGE RELIEF

suspended from the end of a cord carried around the grooved pulley and fastened to the pulley. When the circuit breaker goes out, the lever is lifted and the weight pulls the rheostat arm around so as to cut in resistance in the generator field circuit.

LEON L. POLLARD.

Fairfield, Me.

According to A. A. C. Swinton, the first flight of a model aëroplane propelled by steam is to be credited to the Hon. Charles A. Parsons of turbine fame, who in 1893 built an aëroplane with two 11-foot wings and a tail, and drove it with a steam engine whose cylinder was 1¼ inches diameter by 2 inches stroke, steam being supplied by a boiler 2½ inches diameter by 14 inches long, in which steam was generated at 50 pounds pressure by a spirit lamp. The whole apparatus, including aëroplane, engine and fuel, weighed 4¾ pounds, and it flew for distances of 100 yards at a hight of 20 feet.

Gas Power Department

Notes on Gas Engine Economy

By P. F. Walker

Among the several conditions affecting the economy of operation of gas engines two of the most important are the adjustment of the relative proportions of gas and air in the mixture and the amount of compression. Of these the first is directly in the hands of the operator in the case of most engines of moderate power using ordinary gas, and the second may usually be brought to the desired point if the purchaser knows what he wants and writes his specifications accordingly. The purpose of the present article is to point out the great variation in economy possible by different adjustments and to suggest to gas-engine users certain principles which may serve as guides in determining whether or not an engine is operating at or near its maximum economy. Manifestly, the methods of control differ materially with different styles of speed-regulating mechanism, affecting the completeness with which mixtures are within the control of the operator, but usually a close study of operating conditions will reveal opportunities for adapting the engine to its load in a manner likely to make an impression upon the fuel bill.

The data presented herewith were derived from a series of tests made on a 6x12-inch engine with "hit-and-miss" governor, using natural gas and loaded with a special brake. Conditions were such, however, that losses which could not be measured or computed occurred between the engine and the brake, so that all results are figured on indicated horsepower. The tests were made by two students in the mechanical laboratory of the University of Kansas for graduation theses.

Everything worth while in the gas engine and producer industry will be treated here in a way that can be of use to practical men.

Methods Employed

Since two variable factors were to be investigated, namely, mixture ratio and compression, the plan adopted was to make a series of runs at each compression pressure, carrying the mixture ratio through the widest possible range in each case. Five different compressions were secured, as noted in Fig. 1, the variation being accomplished by attaching plates of different thickness to the face of the piston. It was found possible to operate with mixtures on both sides of that value giving the best economy, so that each curve shows a distinct minimum point for gas consumption, that minimum occurring at different mixtures, however, as plainly shown by the curves.

For determining the proportions of the mixture two large gas holders were used, one for air and one for gas. The gas tank was of sufficient size to supply the engine for a complete run, while the air tank would give the air consumption for about half of the time, after which air was admitted directly from the fan with the tank used to regulate the pressure. A good-sized gasometer in the air line near the engine brought the pressure down to ordinary suction conditions. This method of air measurement, feasible only for small engines, gives results which are reliable within very small limits of error.

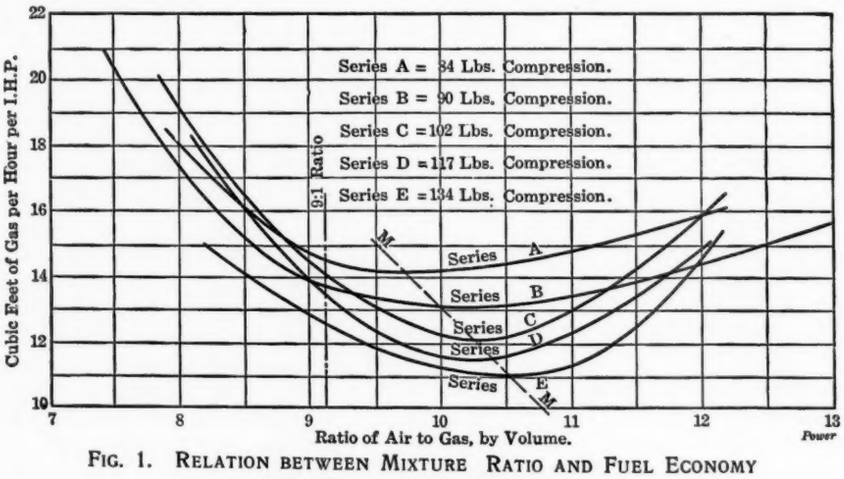


Fig. 1. Relation between Mixture Ratio and Fuel Economy with Different Compressions

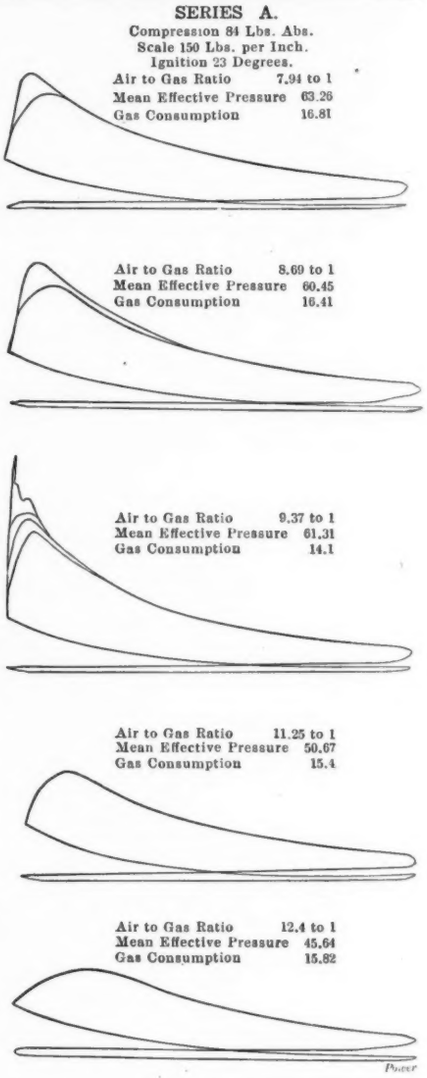

SERIES A.
Compression 84 Lbs. Abs.
Scale 150 Lbs. per Inch.
Ignition 23 Degrees.
Air to Gas Ratio 7.94 to 1
Mean Effective Pressure 63.26
Gas Consumption 16.81
Air to Gas Ratio 8.69 to 1
Mean Effective Pressure 60.45
Gas Consumption 16.41
Air to Gas Ratio 9.37 to 1
Mean Effective Pressure 61.31
Gas Consumption 14.1
Air to Gas Ratio 11.25 to 1
Mean Effective Pressure 50.67
Gas Consumption 15.4
Air to Gas Ratio 12.4 to 1
Mean Effective Pressure 45.64
Gas Consumption 15.82
Power

Fig. 2. Diagrams with 84 Pounds Compression

The question of the amount of load to be carried required careful consideration. In an investigation where the particular engine in use is of first consideration, or when an operating engineer is looking for the best adjustment of valves for any particular load, the load should, of course, be held constant for changing mixtures. In the present instance the general question of mixture ratio was the point at issue, and it was desirable to maintain cylinder conditions as nearly uniform as possible throughout the whole time. The maximum load which the engine could carry was different with different mixtures, and the plan adopted was to keep the load always at from 75 to 80 per cent. of the maximum which could be carried under existing conditions. This brought the load nearly up

to the engine rating for those adjustments favorable to carrying heavy loads, and held the engine always within those limits for which the economy is usually expected to be near the maximum. Under these conditions it is evident that the variations in gas consumption may be attributed directly to variations in mixture or compression pressure, as the case may be, virtually independent of the nature of the particular engine, although different engines of different sizes would give widely different results in absolute gas consumption.

Theoretical Mixture and Heat Value of Gas

Accompanying a study of the actual results of the tests a consideration of certain theoretical principles is interesting and significant. The natural gas from the Kansas-Oklahoma field, as distributed through eastern Kansas, contains from 95 to 96 per cent. of marsh gas (CH_4), by volume, the remainder consisting almost entirely of inert gases, nitrogen and carbon dioxide, with a trace of oxygen. The amount of air required to burn one pound of marsh gas with a perfect mixture is 17.28 pounds. Changing to the volume basis; since CH_4 has a density of 0.55 compared with air, the volume of air required per cubic foot of $CH_4 = 17.28 \times 0.55 = 9.5$ cubic feet, and taking the natural gas containing 96 per cent. of CH_4, the air required per cubic foot of the gas will be

$$9.5 \times 0.96 = 9.1 \text{ cubic feet.}$$

The heat value of CH_4, as determined experimentally, is 23,513 British thermal units per pound. Of this amount of heat, that portion represented by the latent heat of the steam gas produced by burning the hydrogen is not available for raising the temperature during combustion, and hence is not available for work in the gas engine. The available heat is, therefore, 21,340 B.t.u. per pound, which is equivalent to 863 B.t.u. per cubic foot at the standard temperature of 62 degrees used in the test.

Compression Effects

Considering now the effect of compression pressure on economy, we may calculate as follows, using a perfect air diagram and assuming adiabatic compression beginning at the atmospheric pressure of 14.11 pounds and at 73 degrees temperature, which were the average conditions for the tests. For adiabatic compression the temperature varies with the 0.29 power of the pressure, from which the temperature attained at the end of the compression stroke is found. The theoretical efficiency of the cycle, as is well known, is found by dividing the range of temperature along the compression curve by the absolute temperature at the end, from which follows the proportion of heat utilized in work from each cubic foot of gas. The number of heat units required per hour per horsepower, under perfect conditions, is

$$(33{,}000 \times 60) \div 778 = 2545 \text{ B.t.u.,}$$

and the theoretical gas consumption per horsepower-hour is found by dividing 2545 by the number of heat units utilized from each cubic foot of gas. From such calculations, table No. 1 results.

TABLE 1.

Compression pressures, pounds	134	117	102	90	84
Compression temperature, absolute	1025	985	950	915	896
Theoretical efficiency, per cent	48	45.9	42.9	41.7	40.5
Gas per h.p.-hour, theoretical, cubic feet	6.15	6.43	6.88	7.09	7.23
Gas per h.p.-hour, on relative basis, theoretical, cubic feet	1.000	1.045	1.119	1.152	1.182

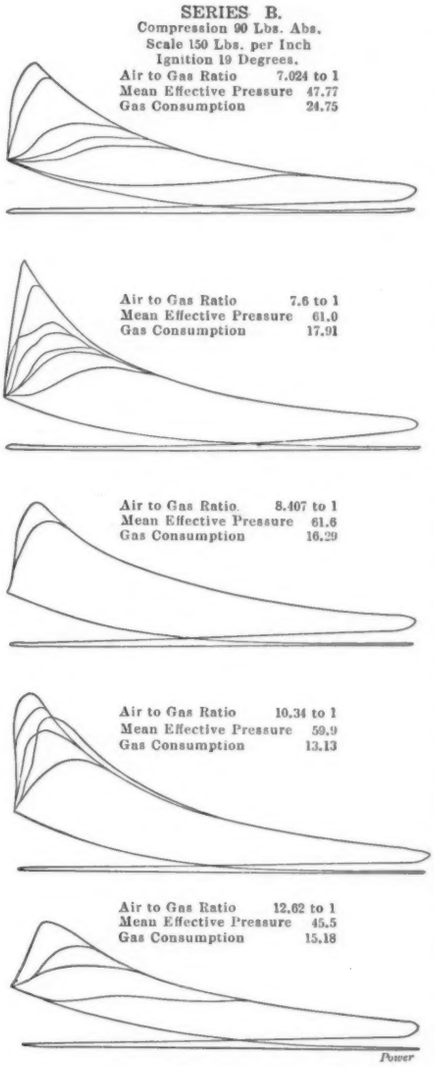

SERIES B.
Compression 90 Lbs. Abs.
Scale 150 Lbs. per Inch
Ignition 19 Degrees.
Air to Gas Ratio 7.024 to 1
Mean Effective Pressure 47.77
Gas Consumption 24.75
Air to Gas Ratio 7.6 to 1
Mean Effective Pressure 61.0
Gas Consumption 17.91
Air to Gas Ratio 8.407 to 1
Mean Effective Pressure 61.6
Gas Consumption 16.29
Air to Gas Ratio 10.34 to 1
Mean Effective Pressure 59.9
Gas Consumption 13.13
Air to Gas Ratio 12.62 to 1
Mean Effective Pressure 45.5
Gas Consumption 15.18
Power

Fig. 3. Diagrams with 90 Pounds Compression

Taking now the actual test results as read from the curves in Fig. 1, first for the theoretical mixture ratio of 9:1 and then for the lowest point of each curve irrespective of mixture, and reducing the figures thus found for gas consumption to a relative basis with the value for the highest compression taken as unity, gives table 2.

TABLE 2.

Compression pressures	134	117	102	90	84
Gas per h.p.-hour, relative, for 9:1 ratio	1.000	1.070	1.120	1.100	1.160
Gas per h.p.-hour, for minimum gas	1.000	1.045	1.100	1.181	1.280

Comparing these latter figures with the corresponding figures above, the remarkable correspondence in values serves to show how close and accurate is the guiding testimony of theory in gas-engine performance as regards the influence of compression pressure. For illustration, the point is clearly established that if a gas will stand compression to 134 pounds, to operate at 102 pounds compression means the consumption of from 10 to 12 per cent. more gas.

Mixture Ratio Effects

Regarding the point of air-gas mixtures, there is no direct method of calculating theoretical conditions. It is plain that a mixture which is too rich in gas does not contain sufficient oxygen to support combustion, and the reduced amount of heat generated accounts for the poor efficiency. It is a similar condition, undoubtedly, which accounts for the fact that the best economic result is secured with a mixture containing considerably more air than is theoretically required, the air and gas not having time to become thoroughly mixed before ignition when barely enough air is present, so that portions of the gas do not meet their full quota of oxygen. For mixtures containing still larger quantities of air the reasons for diminished efficiency are probably two; first, the slower rate of combustion which becomes very apparent on the indicator cards when the mixture ratio becomes greater than 10.5, and second, the increased loss of heat through the exhaust by reason of the increased weight of gas in proportion to the heat generated, escaping at a high temperature.

The more rapid rate of combustion at the higher compression pressures undoubtedly accounts in large measure for the fact that the best economic results under high compression are secured with increasingly large air-gas mixture ratios, as shown by the line *M—M* in Fig. 1 which is drawn through the lowest points on the several curves. That is, up to a point approaching 10.5 parts of air to one of gas for the higher pressures, the more rapid combustion incident to the presence of larger quantities of oxygen and to the rapid propagation of flame before expansion begins, more than counteracts the increasing losses in the exhaust.

Ignition

Another point bearing on the rate of

flame propagation and the form of the indicator card is the time of ignition. The effect on economy of varying the setting of the igniter within comparatively wide limits was shown to be very

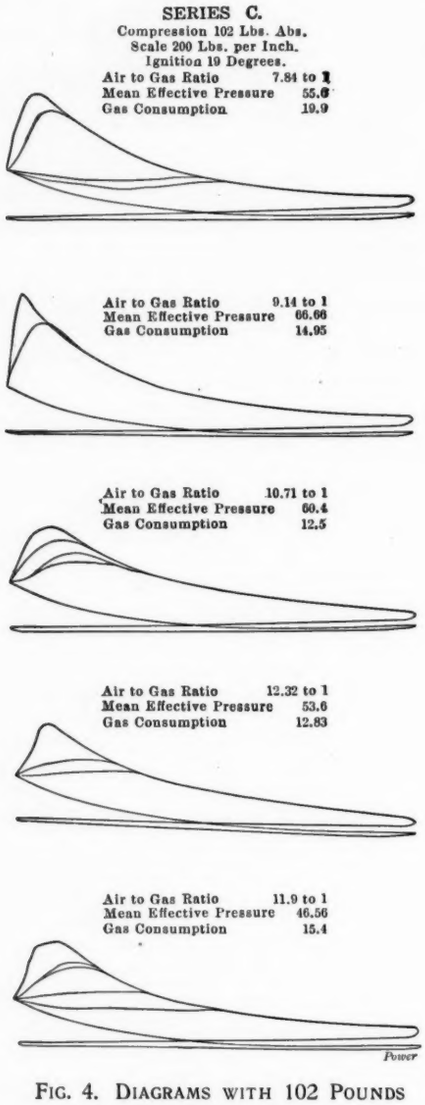

SERIES C.
Compression 102 Lbs. Abs.
Scale 200 Lbs. per Inch.
Ignition 19 Degrees.
Air to Gas Ratio 7.84 to 1
Mean Effective Pressure 55.6
Gas Consumption 19.9
Air to Gas Ratio 9.14 to 1
Mean Effective Pressure 66.66
Gas Consumption 14.95
Air to Gas Ratio 10.71 to 1
Mean Effective Pressure 60.4
Gas Consumption 12.5
Air to Gas Ratio 12.32 to 1
Mean Effective Pressure 53.6
Gas Consumption 12.83
Air to Gas Ratio 11.9 to 1
Mean Effective Pressure 46.56
Gas Consumption 15.4
Power

FIG. 4. DIAGRAMS WITH 102 POUNDS COMPRESSION

small, however, in a series of tests carried out by the writer several years ago, and hence in the present series ignition was simply brought to a point where diagrams of good shape were secured with mixtures not far from those required for complete combustion, and there left for each complete series. It is possible that earlier ignition with lean mixtures would result in flattening to some extent the curves in Fig. 1, particularly at the higher pressures, but it is not probable that any important differences would result. The writer can conceive of no adequate reason to account for the curves *A* and *B* being flatter than the other three, and crossing them as they do, further than in the slight degree in which ignition changes might be responsible. Care was taken to check the accuracy of this condition by repeating significant tests.

In general, a tendency was observed for the curves to become sharper for higher compressions, best results being obtainable through a smaller range of mixture ratios. Mediocre results with high compression are so much better than best results with low compression, however, that there is no reason on this score for hesitating to bring up the compression.

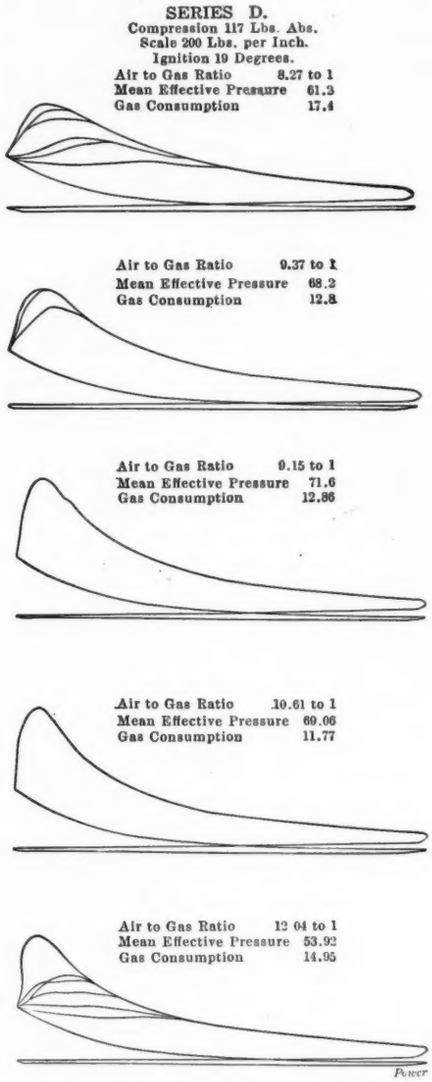

SERIES D.
Compression 117 Lbs. Abs.
Scale 200 Lbs. per Inch.
Ignition 19 Degrees.
Air to Gas Ratio 8.27 to 1
Mean Effective Pressure 61.3
Gas Consumption 17.4
Air to Gas Ratio 9.37 to 1
Mean Effective Pressure 68.2
Gas Consumption 12.8
Air to Gas Ratio 9.15 to 1
Mean Effective Pressure 71.6
Gas Consumption 12.86
Air to Gas Ratio 10.61 to 1
Mean Effective Pressure 69.06
Gas Consumption 11.77
Air to Gas Ratio 12.04 to 1
Mean Effective Pressure 53.92
Gas Consumption 14.95
Power

FIG. 5. DIAGRAMS WITH 117 POUNDS COMPRESSION

THE INDICATOR DIAGRAMS

As usual, the indicator diagrams form an interesting study and a significant index of economic conditions. In most instances the pencil was held intentionally on the drum to secure several cards in succession, the average mean effective pressure being taken. In this manner a truer record of power development is secured than from single cards. In general, it will be observed, the highest mean effective pressures were obtained with mixtures containing but little more than the theoretical amount of air, corresponding with some exactness with the points of greatest economy. The legend "Gas Consumption" on the diagrams means cubic feet of gas per indicated horsepower-hour, reduced to 62 degrees Fahrenheit and 14.7 pounds pressure, absolute. The cards with lean mixtures show plainly the slow rate of combustion as well as the effects of retarded ignition. The possibilities in the line of increased compression and early ignition with mixtures sufficiently lean to do away with pre-

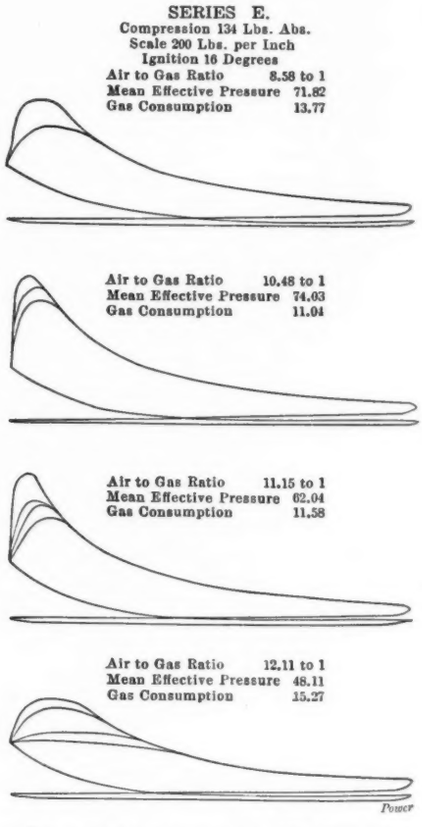

SERIES E.
Compression 134 Lbs. Abs.
Scale 200 Lbs. per Inch
Ignition 16 Degrees
Air to Gas Ratio 8.58 to 1
Mean Effective Pressure 71.82
Gas Consumption 13.77
Air to Gas Ratio 10.48 to 1
Mean Effective Pressure 74.03
Gas Consumption 11.04
Air to Gas Ratio 11.15 to 1
Mean Effective Pressure 62.04
Gas Consumption 11.58
Air to Gas Ratio 12.11 to 1
Mean Effective Pressure 48.11
Gas Consumption 15.27
Power

FIG. 6. DIAGRAMS WITH 134 POUNDS COMPRESSION

ignition dangers furnish an attractive field for more complete investigations on an engine designed for operation with producer gas.

A novel use for Thermit was found last year by the Chicago, Great Western Railroad when it was decided to change the stroke of some of the locomotives. To do this it was, of course, necessary to fill up the crank-pin holes of the driving wheels, and to bore new holes at the desired distance from the center for the new stroke. The Thermit process was used for filling the holes of a set of wheels, thus saving the cost of new cast-steel wheel centers. With the new crank pins in place the locomotive was fitted with new cylinders and has since been in service for over a year.

Readers with Something to Say

Practical information from the man on the job. A letter good enough to print here will be paid for. Ideas, not mere words, wanted.

An Obstructed Exhaust Valve

The power plant supplying power to our mill consists of a 20 and 32 by 32-inch horizontal compound Corliss engine running at 70 revolutions per minute, and two tubular boilers furnishing steam at 85 pounds pressure.

One afternoon the engine stopped from apparently no cause whatever, and the alarmed engineer tried in vain for several hours to start it again. As all his efforts proved useless, an expert was summoned. When the steam-admission valve was opened the engine made several revolutions and then stopped again, and pulling on the flywheel did not help matters any.

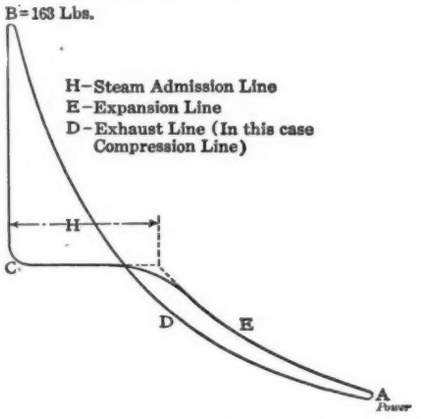


FIG. 1. CARD TAKEN WHILE VALVE WAS OBSTRUCTED

The expert then ordered the indicator to be attached to the engine and in the meantime carefully inspected every external part of the valve mechanism without finding any signs of irregularity. Everything seemed to be in its right place and nothing bent nor broken. After the indicator was attached to the high-pressure cylinder, the engine was started again and during the few revolutions the card shown in Fig. 1 was taken.

The peculiar shape of the exhaust line *A B* shows that the steam could not exhaust at all, the entire exhaust line being a compression curve, the compression beginning at the end of one stroke and ending at the end of the other. The compression was equal to a pressure of 163 pounds per square inch, while the boiler pressure was only 85 pounds per square inch. At the end of the stroke at *B* the admission valve of the engine began to open and the steam which was compressed in the cylinder to 163 pounds per square inch escaped from the cylinder to the boiler and this continued until the pressures were equalized at the point *C*. It was clear that under such circumstances the engine could not run, and it was also evident that there was something wrong with the exhaust valve of the high-pressure cylinder. The valve mechanism was carefully inspected again and the valve taken out, but nothing wrong could be detected.

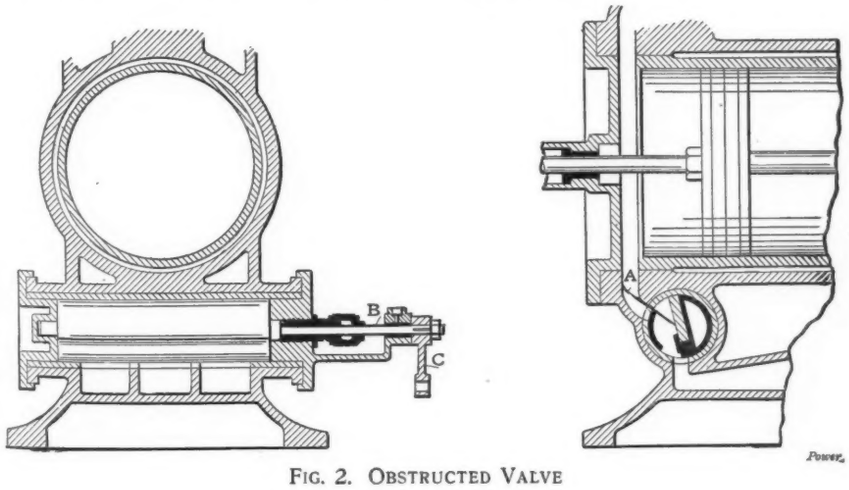


FIG. 2. OBSTRUCTED VALVE

Finally, a bent wire was inserted through the long valve chest, and an obstruction was detected. To ascertain the nature of the obstruction, the cylinder head was removed and a piece of a broken nut-locking device of the piston was found in the exhaust channel. The device consisted of pieces of flat iron, its purpose being to prevent the piston bolts from working loose.

The manner in which the broken plates could have influenced the steam distribution so that the exhaust remained continuously closed, was not at first evident, as the repeated inspection of the exhaust valve did not show any defects. The expert gave his opinion that the valve spindle must have been twisted about 35 degrees although it showed no sign of torsion. This assumption was explained as follows:

First, a break of the nut-locking device occurred and a piece of the plate, marked *A*, Fig. 2, was carried into the chest of the exhaust valve. The rods continued their movement and as the piece *A* prevented the valve from turning, the spindle *B* became twisted. In some way this piece must have been forced back into the exhaust channel or the trouble would have been detected when the valve was taken out.

After the cause of the accident was discovered an examination of the exhaust valve showed a damage that was barely visible at the place where the piece *A* was wedged in.

The valve spindle not being damaged, the lever *C* was replaced in its correct position and fastened with the key. The engine was then started again and showed no more signs of trouble.

C. A. SCHRANZ.

Camden, N. J.

The Designer Can Save Repairs

One of our high-speed engines recently developed a pound in the main bearing which was not of a very serious character and the engine would in all probability have continued to run for an extended period of time without causing a shutdown. But the rule at the plant was to maintain everything connected with the engine room in first-class condition; hence the pound had to be eliminated.

At first it was surmised that the crank shaft was not in alinement, but a line dropped through the centers showed this supposition to be unfounded. The next step was to rebabbitt the main bearing, but the pound still remained. Many adjustments were made on the cap and numerous paper liners were inserted and withdrawn but without causing any relief. Finally it was decided to take out the crank shaft, place it in a lathe and true up the journals. The reason for doing this was based on the statement of one

of the engineers who claimed that the main journal was worn eccentric and as proof he showed how the cap on the main bearing would not remain steady under any amount of pressure, and further, that at a certain point in tightening the holding-down bolts, heat was developed while to all appearance the cap was slack.

Fig. 1 illustrates the type of engine. Considerable difficulty was experienced in removing the crank shaft and disk from the engine frame, the designer of the engine having made the opening in the

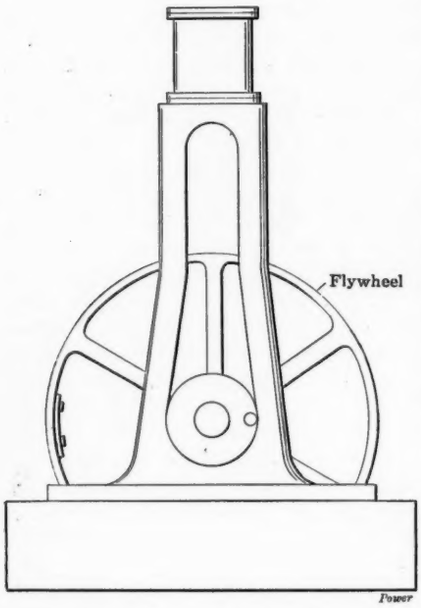


FIG. 1. TYPE OF ENGINE

frame too small to allow the disk and shaft to be pulled directly through. Many attempts were made to pass the disk through the opening but all failed. It was

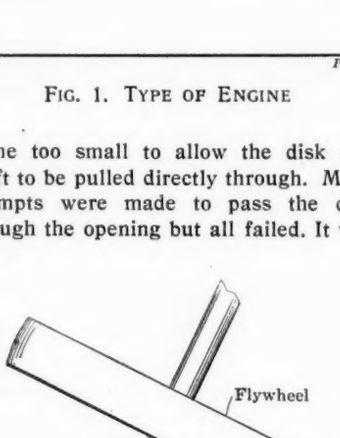


FIG. 2. METHOD OF REMOVING CRANK SHAFT

self-evident that the disk had been gotten into position through this opening and there was no reason why it should not come out.

Finally it was decided to tip the flywheel as shown in Fig. 2, thus throwing the edge of the disk just outside of the opening, it then being an easy matter to pull the disk and shaft out of the flywheel.

This illustrates how a little thought on the part of the designer could have saved over a day's labor and much worry on the part of the engine-room force.

WILLIAM KAVANAGH.

New York City.

Lubricating with Graphite

The writer was asked recently to advise upon a lubricating difficulty, which, although concerning only a small oil engine of two or three horsepower, it is of interest, as the solution opens up a very wide field of possibilities. The engine in question runs the electric-light plant of a small country house and is somewhat of an amateur production. The cylinder, which is placed horizontally, is part of a vertical car engine with its proper piston, valves, etc., the remaining parts, such as the connecting rod, crank, bearings and bedplate all being of an amateur design. Although a credit to its builder and very ingenious, it has always been rather troublesome. The bedplate, which is bolted to timbers, is made of ¾-inch plate, and owing to several cuts being taken out of it to accommodate the crank and flywheel, it is by no means as rigid as the conditions require. The consequence is that when running it springs perceptibly between the cylinder and the crank shaft, thus throwing the engine somewhat out of alinement.

For several months this engine has been run with the best grade of heavy motor-car oil, liberally applied to the projecting end of the piston by means of a swab and a drip lubricator. In this way it has been possible to keep the engine running, but since the lubricator is emptied every ten minutes and the swab freely used, the cost both in oil and labor has been very high.

Upon examination after a short run, it was found that in spite of a thorough oiling before starting and the continued use of the lubricator, the cylinder was quite dry and in places showed signs of seizing. Obviously, the oil originally in the cylinder at once burned, and of that fed to the piston, practically none entered the cylinder. Under the conditions oil was clearly out of the question, and as a believer in graphite the writer recommended its trial. The first few applications produced little, if any improvement, but by the time four ounces of the best lubricating graphite, with a guaranteed purity of 99 per cent. and mixed with a little oil, had been used, the engine began to behave much better. Although the above conditions are probably about as unfavorable as will be met with, the experiment has now proved entirely satisfactory. Only sufficient oil is used to act as a carrier for the graphite, which is applied in small quantities at infrequent intervals during the run. The compression of the engine has improved noticeably, and it now develops 50 per cent. more power as measured on the switchboard instruments.

There is no doubt whatever in the writer's mind that there is a large field for graphite in one form or another in cylinder lubrication. The difficulty of introduction to the cylinder has been overcome in several ways, notably by employing a deflocculated form of graphite which remains permanently suspended either in oil or water. The main point to look to, however, is purity in the material used. It is well known that the average commercial mineral graphite is often very impure, containing silica, clay, mica, and other substances detrimental to good lubrication. It is therefore necessary to use the very highest grade only, and to secure some guarantee that its purity shall not be lower than 99 per cent.

There is a 3000-horsepower, horizontal steam engine using superheated steam, in a large London power station which is now running on graphite alone. It is applied only to the high-pressure cylinder, and no oil has been used during the past twelve months. There are two additional points in favor of its use, in that there is no trouble experienced with oil in the boilers and cooling towers. From practical experience with engines of many kinds, the writer is strongly of the opinion that it will pay every engine owner to investigate closely the question of graphite lubrication.

FRANCIS H. DAVIES.

London, Eng.

Saving of Fuel Analyzed

Some time ago I was asked to examine a factory power plant which, according to the manager, did not operate economically. It consisted of return-tubular boilers, with safety valves set for 90 pounds pressure, a 26 and 46 by 36-inch, Wright tandem-compound steam engine, well along in years, and the different power-plant accessories.

Although the engine ran smoothly at a speed of 75 revolutions per minute, a peculiar report of the exhaust gave me the suspicion of a faulty steam distribution. Fig. 1 represents the indicator diagrams which were taken and shows that the engine was underloaded considerably.

No fault could be found with the high-pressure cylinder, but the low-pressure was found to be merely a drag on the engine. At times it developed 15 negative horsepower.

A combined diagram, as shown in Fig. 2, indicated that changes in the valve setting would not improve matters due to the large cylinder ratio of three to one, which is used for condensing engines. This made an economical steam distribution between the two cylinders impossible. Especially with a light load such as

the engine was carrying, a considerable loop in one or both of the indicator diagrams could not be avoided.

To illustrate this, an expansion line has been drawn in Fig. 2. It represents the diagram with the shortest cutoff for the lowest load at which a loop in the diagrams of either the high- or the low-pressure cylinder would not show, as the terminal pressure in the low-pressure cylinder equals that of the atmosphere. This shortest cutoff, however, averages 50 per cent. for both cylinders and the corresponding lowest load is 525 horsepower, while only a 200-horsepower load was being carried.

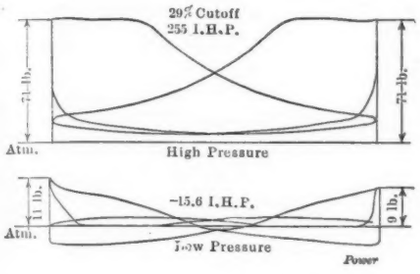


FIG. 1. HIGH- AND LOW-PRESSURE DIAGRAMS BEFORE CHANGES WERE MADE

Economical operation under the conditions mentioned was, therefore, an impossibility, and as the load could easily be carried by the high-pressure cylinder, the low-pressure cylinder had to be abandoned completely. A 26 by 36-inch simple engine was made of the tandem compound.

A 26 by 36-inch engine running at 75 revolutions per minute and on 85 pounds steam pressure may be rated at 320 horsepower normal capacity, with a maximum of 400. The 200-horsepower load of the factory made our rearranged engine still underloaded.

As the low-pressure cylinder was located close to the engine bed and the facilities for removing the low-pressure piston were poor, the piston was left on the rod and only the ring was removed by springing it open to pass the piston rod between the cylinders. The low-pressure admission and exhaust valves were also removed but their stems left in the stuffing boxes to prevent leakage. The weight of the low-pressure piston was supported by a bronze shoe about a foot long securely fastened to it and fitting the radius of the cylinder. Exhaust steam from the high-pressure cylinder, in condensing, would deposit enough oil for the sliding surface.

These changes enabled the steam leaving the high-pressure exhaust valves to pass, without appreciable resistance, into the atmosphere through the wide openings in the low-pressure valve seats and the large exhaust pipe.

The inertia of the reciprocating parts, practically the same as before the change, had now to be cushioned in one instead of in two cylinders. The compression in the high-pressure cylinder was therefore raised to approximately 40 pounds per square inch, which proved high enough to produce a smooth running of the engine.

A diagram taken after the changes were made is shown in Fig. 3, and represents the same factory load as is shown in Fig. 1.

Immediately after the changes were made an average saving of $50 a week was shown in the coal bill. It may be interesting to analyze this saving with the data we have.

The engine averages 90 running hours a week, carrying an average load of 200 horsepower. At a steam consumption, after the improvements were made, of 28 pounds of steam per horsepower, it consumed 504,000 pounds of steam per week or, with an evaporation of seven pounds of steam per pound of coal, 36 tons of coal per week. As the price per ton of coal is $2.90 the weekly coal expenditures were $104. Formerly they averaged $154. Therefore, $50 a week or 32 per cent. of coal was saved, which may be distributed as follows among the three improvements made:

The first one was the elimination of the friction of the low-pressure piston ring and valves. The gain was estimated as follows: The engine was designed for 620 horsepower and had a mechanical efficiency of about 83 per cent.; the friction loss was, therefore, 105 horsepower, of which one-third or 35 horsepower could be allotted to the low-pressure ring and valves.

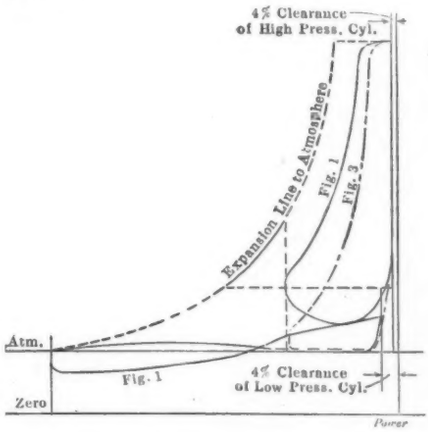


FIG. 2. COMBINED DIAGRAMS

The second one was the elimination of the 15-horsepower negative load of the low-pressure cylinder.

The third gain was the reduction of the back pressure on the high-pressure piston to the pressure of the atmosphere. This saved 50 horsepower.

A statement of the power of the engine is as follows:

305 horsepower, which the present engine could have developed with same cutoff as in Fig. 1.
50 horsepower, loss by back pressure.
255 horsepower, developed by high-pressure cylinder as shown in Fig. 1.
15 horsepower, drag of low-pressure cylinder.
240 horsepower, indicated horsepower before the change.
35 horsepower, friction of low-pressure piston ring and valves.
205 horsepower, shown by diagram in Fig. 3 of simple engine after the change.

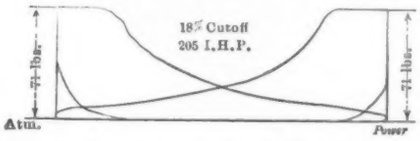


FIG. 3. DIAGRAMS AFTER CHANGES WERE MADE

The 100 horsepower saved here amounts to 33 per cent. This again can be measured with the cutoff, which in Fig. 1 is 29 per cent. and in Fig. 3 is 18 per cent. Figuring on a clearance of 4 per cent., the ratio of steam consumption is as 33 is to 22, representing a saving of about 33 per cent.

RULOF KLEIN.

New York City.

An Emergency Decision

The three feed pumps supplying the boilers in our plant all have one suction and one discharge pipe in common. A leak had sprung in the suction pipe, and had caused much annoyance all day in spite of the putty, paint and water which we administered to it. Toward the end of the afternoon it became evident that a new gasket must be put into the leaky joint, and I became convinced that with the flange nuts loosened and everything ready, I could insert it in less time than the water in the column glass could be evaporated, for to shut down the plant would have been inexpedient.

While the pumps were slowly filling the boilers, the two flanges were held with a pair of iron clamps, and the bolts removed. When all was ready the main suction valve about 10 feet from the pumps was closed to keep the pumps primed, the joint pried open, the old gasket scraped off and a new one inserted. When three or four bolts had been secured orders were given to open the suction valve and start up the pumps. Just then one of the firemen came to report that there was yet ½ inch of water showing in the boiler glasses.

My relief was great, but it was only momentary, for the next instant my helper rushed out to say that he had been turning the handwheel of the suction valve for five minutes without obtaining any result. Instantly I divined the trouble, for it was only the week before that I had taken out a valve stem on the discharge line, the end threads directly exposed to the water having been badly corroded. I rushed to verify the helper's

statement, and ordered the fires banked. Grabbing a coal maul I brought it down lustily on the offending valve stem, and evidently crushed the thrust collar at the first blow, for the stem yielded. By squeezing down hard on the stuffing box I managed to get two threads on the stem to take hold in the disk. With the stuffing-box gland as the thrust bearing and a 14-inch monkey wrench on the wheel to overcome the binding of the broken thrust collar, the valve opened, and we had the pumps running before the water had entirely disappeared in the glass gages, with a drop in steam pressure of less than 10 pounds.

M. L. LEE.

Cambridge, Mass.

Centrifugal Pump Troubles

Every engineer in charge of centrifugal pumps has perhaps at some time had more or less trouble in maintaining the suction, due to their peculiar principle of construction. They are usually designed to handle a large volume of water, at the same time working against a high pressure; but as a usual thing they will not permit being set much above their source of supply without causing trouble. A case of this kind occurred at the plant in which the writer was employed and while the scheme employed to overcome the trouble may not be new, I shall describe it, hoping that someone may profit by it.

The plant was equipped with a jet condenser, taking its suction from a cooling-tower reservoir and discharging into a hotwell. The discharge was pumped back over the cooling tower by a motor-driven centrifugal pump. As may be seen from the sketch, this pump was placed at a considerable hight above the hotwell. If for any reason the pump stopped (as it frequently did on account of the motor current being cut off) while the well was full of hot water, it was a very difficult matter to get it working again as this type of pump will not raise very hot water.

The remedy was to drill and tap a hole in the condenser and from there run a 1½-inch pipe to the discharge side of the centrifugal pump. A globe valve was placed at *A*, and there already was a gate valve at *B;* hence, to operate, it was necessary only to close valve *B* and open valve *A*. By doing this the vacuum in the condenser immediately removed all air and vapor from the centrifugal pump and the latter would pick up at once. By being careful to close valve *A* before opening valve *B* we never had any trouble with the suction breaking. We also used this system to prime the pump when the foot valve shown at *C* happened to become wedged open, thereby causing all the water to run out of the suction pipe.

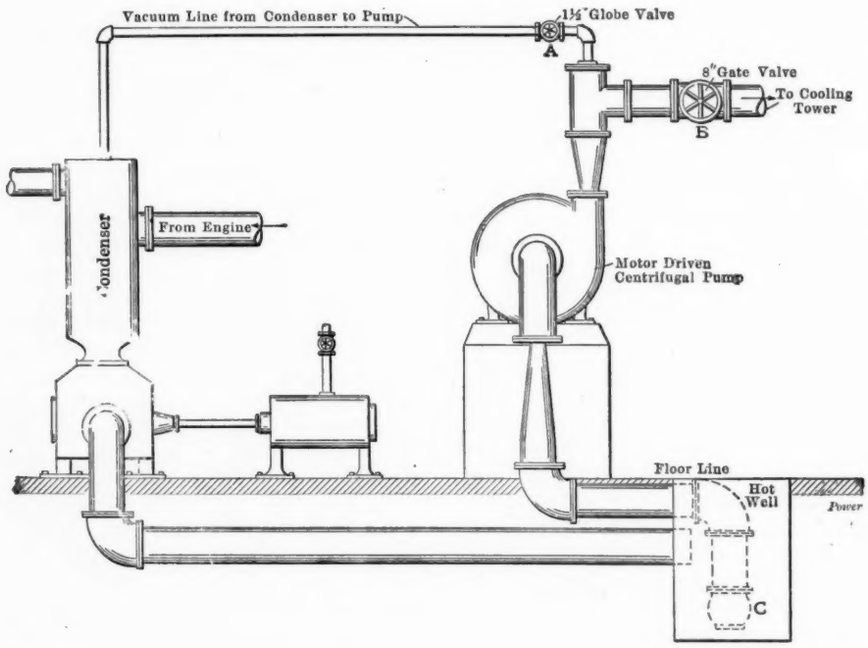


DIAGRAM OF PIPING, SHOWING LINE CONNECTING CONDENSER WITH PUMP

This system can be used in connection with any condenser and all cases of balky pumps can be successfully handled by it. It will be found superior to city-water pressure for priming pumps on account of being quicker.

LEE BAILEY.

Meridian, Miss.

Trouble with a Clutch Pulley

I should like to hear from readers of POWER who have had experience with clutch pulleys, running intermittently on line shafting. My trouble arises from the following cause: The belt drives a compressor, and having to be kept taut, it causes the pulley bearing (when pulley is idle) to wear on one side. This gives the pulley a tendency to stop in the same position each time and necessitates a rebabbitting of the bearing every two or three months. Would a countershaft overcome this trouble?

F. E. HAUGHT.

Means, Ky.

Questions Regarding Dutch Ovens

There has been much discussion of late in this locality upon the subject of dutch ovens, and I should like to have the following questions submitted to the readers of POWER, which we trust will result in bringing out some of the points that have been troubling us:

1. Can a dutch oven be used to burn coal economically?
2. If so, how should the bridgewall be constructed?
3. How far should the grates be from the boiler?
4. Can coal and refuse be burned at the same time?

M. SOMBERG.

Merrill, Wis.

A Loose Crank Pin

I have charge of a tandem compound engine carrying a heavy load under 175 pounds steam pressure. About a year ago the crank pin became loose in the disk, and the conditions of service were such as to require it being repaired at once. I took for granted that there was a shoulder on the pin at the place where it fitted into the disk, and accordingly procured a blow torch and began to heat the end of the pin. I then beaded the end of the pin, but soon discovered that there was no shoulder and that I had drawn the pin into the disk about ⅛ inch. As a result I spoiled the job.

It held, however, until we had an opportunity to take it to the machine shop. We finally drilled a ½-inch hole, partly in the disk and partly in the pin, and into this hole screwed a pin as tightly as possible. Although the repair has held for a year, I find that the brasses wear down faster and it is harder to prevent knocking.

I should like the opinions of some readers of POWER as to the cause and probable remedy of this trouble.

P. C. FORGARD.

Lake Preston, S. D.

Questions Before the House

Comment, criticism, suggestions and debate upon various articles, letters and editorials which have appeared in previous issues.

A Broken Hook Block Bolt

Replying to the article by A. W. Griswold in a recent issue, in which he related "the breaking of a latch-block bolt on the low-pressure head-end hook of a cross-compound Corliss engine," I fail to see any reason why the engine, with a medium load, could not have continued running providing there was some way of adjusting the cutoff on the low-pressure valve which was still active.

Most modern Corliss engines are equipped with a device on the low-pressure governor gear by which the cutoff of the low-pressure valves can be varied through a wide range. Unless there was some such device to take care of the excessive receiver pressure, the engineer took the proper course in shutting down, except that his first thoughts should have been on the safety of the engine and not on the possible inconvenience to any of the mill hands.

W. C. LIGHT.

Painesville, Ohio.

Low-Pressure Diagrams Analyzed

In the April 26 number of POWER, H. Seth asks for information about the indicator diagram registered by the low-pressure cylinder of a tandem-compound engine. This card reminds me very much of the one in my article on another page of this issue.

The different events of the stroke for which he asked, are *A*, point of admission; *E*, expansion starts; *B*, exhaust; and *C*, point of compression.

The engine is running greatly underloaded. Evidently the low-pressure cylinder is a drag on the engine, developing negative horsepower. Mr. Seth will find, moreover, that if he has the engine run condensing, in both cylinder ends the exhaust ports will open and close too late. Advancing the eccentric which operates the exhaust valves will then be necessary.

He can treat the problem, however, in the way described in my article, and abolish the low-pressure cylinder altogether.

If he is willing to give the make, size and speed of the engine, the weekly running hours, the kind and price of coal, type and condition of boiler, and average indicator diagrams from both cylinders, it will be an easy matter to estimate closely the amount of savings which can be made and at what expense.

As the reproductions of the diagrams in POWER have to be reduced in order to suit the columns, the mere mention of the scale of the spring used is of no value and Mr. Seth would do well to mark the actual inlet pressure on the high-pressure diagram, as shown in my article and the distance *F* on the low-pressure diagram, both in pounds per square inch.

RULOF KLEIN.

New York City.

Flue Collapse in Lancashire Boiler

In the issue of April 5 a report appears written by Mr. Leese relative to the collapse of a Lancashire boiler, the conclusion of the report ending with, "WHY?"

A consideration of the case seems to point out that the principal cause of the explosion was unequal expansion brought about by lack of circulation, assisted, no doubt, by scale or grease on the water side of the flues.

It is no uncommon thing to find a boiler, which has been off for cleaning purposes at the week end, generating steam on Monday morning by 6 o'clock although the temperature of the water underneath the flues is little more than lukewarm. Unequal expansion and racking strains can only result from such conditions.

If part of the boiler flue was coated with scale ⅛ inch thick, this would have the effect of reducing the heat transmission through that part of the plate by nearly 20 per cent.; consequently the plate would become overheated and, assisted by the unequal expansion above referred to, would probably buckle slightly and the internal pressure of the boiler would quickly do the rest.

Again, even if the boiler plate was free from scale, if, during the time of cleaning, part of the flue had become greased owing to a leaky lamp, this alone would be quite sufficient to account for the blister appearing. As this blister approached the fire the heat would become more intense on the damaged part, hence the reason why one of the stokers heard the rushing noise of steam and water before the actual collapse took place.

In Mr. Hutton's book, "Steam Boiler Construction," the following appears under the head of defective circulation and appears to be a fairly satisfactory explanation of the present case:

"When steam is generated in confined spaces from which it cannot rise freely, it is liable to drive the water before it, and leave the heating surfaces dry, resulting in priming and deteriorated or burned metal surfaces. Steam has a natural tendency to cling to heating surfaces and when water spaces are so cramped that the ascending and descending currents cannot flow separately, circulation cannot take place, and the water is put into a state of perturbation. Therefore as the steam cannot rise through the superincumbent water as fast as it is generated, it accumulates on the heating surfaces forming a film between the heated plate and the water, and causes inflation of the water, which rises to a greater hight in the boiler than that due to the natural position of the water and steam. In such cases the quantity of water indicated by the water gage is greater than the actual quantity in the boiler.

"Defective circulation may cause a portion of the heating surface to become so highly heated as to repel the water, and become covered with a layer of spheroidal fluid, on which the mass of water will float without contact with the metal.

"*The spheroidal condition of the water* is that state observed when water is applied to a highly heated metal plate. The water is repelled by the radiant heat and does not wet the plate, but rolls on its surface in liquid drops or flattened globules buoyed up by or resting on cushions of their own vapor. The tendency of the water to become spheroidal is promoted by the presence of a coating of greasy or other deposit on the heating surfaces, which prevents contact of the water with the hot plates, and the water covering the hot surfaces without wetting them is maintained in a spheroidal state.

"When a plate is overheated, a spheroidal layer of water several inches thick may be repelled and constantly supported. The temperature of the spheroidal layer is always lower than its boiling point. It may be assumed that the temperature of the furnace plate from which water has been repelled will within one minute's time become at least 1100 degrees Fahrenheit, and the strength of the plate will have become seriously impaired."

The circulation of water inside a Lancashire boiler is one of the most simple objects to attain as it merely requires a

sectional plate to be fixed about 6 feet from the rear end of the boiler, the upper edge of which should stand 12 inches above the working level of the water in the boiler, the lower edge near the bottom of the furnace flues.

Into the chamber formed by the sectional plate, the end and sides of the boiler, the feed water is pumped and as it cannot back toward the furnaces, it gravitates to the bottom of the boiler and passes onward to the front end, assisted in doing so by the aspirative power of the steam generated over the furnaces.

As over 60 per cent. of our fuel is coke (solid carbon) and the whole of the heat from it is given off radiantly this points to the fact that fully 60 per cent. of the total heat of the fuel is taken up by the first 6 or 8 feet of the boiler; and as 20 per cent. of the heat must go to produce draft, this only leaves 20 per cent. of the total heat to be distributed over 90 per cent. of the boiler-heating surface.

Under the above conditions, there is no wonder at the accident to which Mr. Leese's article refers; the wonder is that we have so few accidents of a similar nature and it speaks well for the construction of Lancashire boilers that they have been able to withstand such cruel treatment with so few failures.

As the bulk of the heat contained in our fuel is transmitted to the boiler in the first few feet of the furnace flues and as water is a poor conductor of heat, the design of any boiler should be such that the heat and water are proportionately distributed, making each square foot of flue-heating surface do a proportionate share of the work.

With the present Lancashire boiler, 1 square foot of heating surface at the furnace end transmits as much heat to the water as 4 square feet at the rear end and still the last 6 feet of the boiler contain about 2000 pounds more water than the first 6 feet.

W. H. CASMEY.

Leeds, England.

Opening a Clogged Blowoff Pipe

In the April 26 number, G. E. Miles describes a new method of freeing a clogged blowoff pipe. He says that it would have been a very bad obstruction indeed which could have resisted his treatment. I can agree with him that it would. He does not say what pressure he had in the boiler at the time or why he did not burst the blowoff pipe or feed line. One of the first lessons an engineer or fireman usually learns is to open and close blowoff cocks or valves very slowly as a quick closing is liable to rupture the pipe or fittings. As the feed-line pressure must be greater than the boiler pressure it stands to reason that the sudden shock to the blowoff caused by Mr. Miles' treatment must have been much greater than any strain that could be caused by the sudden closing of a blowoff cock under ordinary conditions. We hope that Mr. Miles' method will not become prevalent among engineers with families to support.

I suggest that a safer method would be to use dynamite as the attendant could light the fuse and reach a position of safety before the blowoff pipe ruptured.

C. E. BASCOM.

Uxbridge, Mass.

Tile Roof Furnaces

I was much interested in the article, "Tests of Tile Roof Furnaces," which appeared in the April 26 issue.

Chief among the reasons that caused this article to appeal to me is the fact that we have three Heine boilers whose furnace roofs are of the T-tile type and I have recommended the purchase of enough of the C-tile to roof one furnace in an effort to improve combustion, decrease smoke and increase boiler efficiency.

It is my opinion that the results of the tests were due more to furnace design than to the furnace roof. In the figure in which the arrangement of boiler and furnace is shown it will be seen that the gases have a comparatively long distance to travel from the grates to the tubes and consequently there is ample time for complete combustion to take place. With the T-tile roof, however, combustion is not quite so complete, due to the fact that a small portion of the volatile hydrocarbons driven off come into contact with the lower row of tubes which are of comparatively low temperature; hence, some smoke could be seen while using this type of roof.

It is my idea that the circulation of water in the boiler would be better when using the T tile than when using the C tile and, of course, there would be more heating surface exposed with the former than with the latter.

Notwithstanding these two facts, the C tile improved the combustion enough to bring the boiler efficiency up to within 3 per cent. of that obtained with T tile.

The tests are valuable in that they show that under conditions similar to those under which they were made, a roof of the T-tile type is preferable to that of the C-type tile. That is, where complete combustion can be obtained, a T-tile roof gives better efficiency. If, however, the grates were directly under the front end of the boiler and hand firing were employed, and a coal high in volatile matter were used, as is the case in our plant, I believe that a roof of the C type would give better results.

I would be glad to read a broad discussion on smoke prevention, types of furnaces, etc., and, therefore, hope to get the opinion of other readers.

C. A. RUSS.

Hattiesburg, Miss.

Referring to the article in the issue of April 26, "Tests of Tile Roof Furnaces," the results, as presented, appear to indicate that the boiler equipped with the tiles, leaving the lower half of the bottom row of tubes exposed to the furnace, showed an efficiency of 68.6 against 65.6 for the boiler equipped with the tile roof. In this connection, I wish to call attention to the fact that the report of the university is in error in assuming a greater efficiency for the boiler with the exposed tubes. The conditions of combustion were not the same in the tests with the two forms of apparatus. In the tests with the exposed tubes, the CO_2 was 7.5, while with the tile roof it was 6.8. Thus, there was a greater loss in hot gases of not less than 3.5 per cent. with the tile roof, while the difference in efficiency reported is 3 per cent. I very much regret that in these days, when the elimination of smoke is getting to be such an important matter, such an ill advised and inconsistent statement should have been made by the experiment station, when investigations here in Chicago, covering a period of several years, indicate that there should have been a greater efficiency secured with the tile roof, with corresponding conditions of combustion. I am unable, however, for lack of information, to criticize the accuracy of the tests, as the only available data are those contained in the Bulletin.

A. BEMENT.

Chicago, Ill.

Perpetual Motion

I noticed the article by S. Kirlin on page 811 of the May 3 number, entitled "Perpetual Motion."

A man in this town had practically the same thing only it was arranged with bellows. He claimed it would work and is willing to demonstrate it to anyone for $50. I have not invested.

HARRY B. DAY.

Sidney, Ia.

In regard to the perpetual-motion machine described in the May 3 number, I fail to see how it would keep in motion if started.

Mr. Kirlin claims that there is a difference of 12 pounds, due to buoyancy, in favor of the cylinders going up. If so, the plungers would be forced in a certain distance, compressing the air, and as the cylinders are all in communication through the rubber hose, the plungers in the descending cylinders would be forced out by the equalizing of the pressure in-

side and this will cause them to displace the same amount of water as the ascending cylinders. Hence the machine will finally stop.

F. D. STONE.

Hudson, Mass.

Mr. Kirlin's perpetual-motion device is an ingenious though not an original one. There have been, to my knowledge, three machines planned on the same principle (or lack of it). Two of these consist of weighted bellows at the extremities of arms radiating from a hub on the (hoped for) power shaft. The weights are arranged to collapse the bellows on one side and expand them on the other, the buoyancy of the latter being expected to cause rotation. The other device similar to Mr. Kirlin's is practically identical to it, being different only in mechanical details.

Briefly, the fallacy of the invention lies in the fact that any one of the plungers, when emerging from its cylinder at the lowest point of its travel, is obliged to perform work against water pressure and this work is equal to or greater than that which it returns by virtue of its increased buoyancy. For the sake of making this clear let us consider one of the cylinders at the time when the plunger is about to emerge from it. The pressure on the face of the plunger is that of the water column above it, or,

Depth of immersion $\times$ *area of plunger face* $\times$ 62.5,

62.5 being the weight of 1 cubic foot of water. Suppose that the mean depth of the plunger's face while falling is 10 feet, the area ½ foot, and the stroke 2 feet; then the total force acting upward on the plunger is,

$10 \times \frac{1}{2} \times 62.5 = 312.5$ *pounds.*

The work done to overcome the water pressure is this force times the stroke of the plunger, or,

$312.5 \times 2 = 625$ *foot-pounds.*

Now, the added buoyancy force equals the weight of the water displaced by the plunger or,

$\frac{1}{2} \times 2 \times 62.5 = 62.5$ *pounds.*

This acts upward (if to the water level) 10 feet and the work done during this upward motion is,

$62.5 \times 10 = 625$ *foot-pounds.*

This means that the work which the device is required to do in order to operate exactly equals that which it is theoretically capable of delivering.

This demonstration does not closely apply to the device as described because of the influence of the plunger which, simultaneously to the one emerging, descends into its cylinder. A similar demonstration, however, may be made for this case.

It may be objected that not the device but gravity does the work against the water pressure since the weighted plunger, in falling, is practically separate from its cylinder. This is quite true. But, to prove that this work is eventually restored by the "power shaft," it is only necessary to observe that, in consequence of the plunger falling 2 feet, it must be elevated that amount more than the upward travel of its cylinder.

It is difficult to invent a perpetual motion of this character without repeating someone's else ideas. It has been an alluring field for inventors, as countless records testify. Nowadays, however, popular taste runs more to what may be called "near-perpetual motion," having even more seductive attractions and less exposed vulnerability to common sense than the old timers they supplant. Probably at the end of time there will be some knaves and some fools still aiming at this goal. And all the time perpetual motion is an accomplished fact, daily to be observed, the only thing necessary to its utilization being a proper harness.

J. C. SMALLWOOD.

Philadelphia, Penn.

Compression in High- and Low-speed Engines

In POWER for April 26, Mr. Westerfield wishes to know why single-valve, high-speed engines have more compression than low-speed, four-valve engines. One reason is that with the slow-speed engine, the engineer in charge can adjust the exhaust valves to suit the existing conditions, while with the high-speed engine, equipped with an inertia shaft governor, he cannot. Hence, the builder of the single-valve engine usually gives enough inside lap to insure sufficient compression in case the engine should be run condensing. If the engine is later changed to run noncondensing, the inside lap can be reduced by the operating engineer. On the other hand, if the single-valve engine had only the right amount of compression to run noncondensing, the engineer could not easily add inside lap to the valve.

Another reason is that the piston of a short-stroke engine travels faster than the slow-speed engine piston for a given piston speed per minute. Taking his example of two engines, one having a stroke of 12 inches and running 300 revolutions per minute and the other having a stroke of 36 inches and running 100 revolutions per minute, the speed per minute is the same in each case. The reciprocating parts of the engine making 300 revolutions per minute would have to stop 600 times in each minute, while the reciprocating parts of the engine having a 36-inch stroke would stop only 200 times each minute. It will be seen that the short-stroke piston will have to travel enough faster than the long-stroke one to make up for the additional 400 stops it has to make each minute. Thus it requires more compression. There is no doubt but that many single-valve, high-speed engines have too much compression and that their economy could be very much increased by reducing the inside lap, as I have pointed out in a previous contribution in POWER.

C. E. BASCOM.

Uxbridge, Mass.

Trouble with an Idler

In the April 26 issue, W. F. Cox attributes the cause of the trouble with his idler to too much wrap of the belt on the idler pulley.

I am quite sure that Mr. Cox is mistaken. The probability is that his idler as first placed was a trifle out of line which was corrected when he turned the idler around and placed it nearer to the driven pulley. Even if it was not corrected its effect on the belt was counteracted by the fact that the distance between the idler in its second place and the driven pulley is so short that it does not cause any appreciable trouble. The farther from the driven pulley an idler is placed, up to a point halfway or more to the driver, the more easily the belt is influenced by anything which tends to make it run off the pulley.

CHARLES F. CHASE.

New York City.

Pipe Covering Materials

The article by J. H. Boughton on "Losses by Radiation from Steam Pipes," in the March 29 issue has just come to my notice.

To the first four paragraphs of the article I would take no exception other than to the statement in regard to the life of 85 per cent. magnesia covering. I could refer Mr. Boughton to many plants where the genuine 85 per cent. magnesia has been in continuous use on high-pressure steam pipes for twenty years and is in perfect condition today. During some tests made by Prof. C. L. Norton at the Massachusetts Institute of Technology in 1898 a section of 85 per cent. magnesia covering which had been in continuous use on the high-pressure steam main running between two of the Institute buildings for ten years, was thoroughly tested and declared to be as serviceable in every way as when applied and, in fact, slightly more efficient as a nonconductor of heat than a new section of covering of the same make. This was thought to be due to the fact that the old section had all the moisture dried out of it while new covering might have retained a little moisture in the spaces between the crystals of carbonate of magnesia. All nonconducting covering, of course, depends on the presence of the air cell for its efficiency and it is the way in which the many crystals of carbonate of magnesia lie together, forming the tiny air cells, that makes it the excellent nonconductor of heat that it is so generally recognized to be.

I have had long experience in heat- and cold-insulation work, and experience leads me to believe that one cannot place any limit on the life of genuine 85 per cent. magnesia covering.

Another statement made by Mr. Boughton, to which I would take exception, is that in regard to sponge-felt covering, which he refers to as having practically the same insulating value as the magnesia. A very complete and careful test made by Mr. Stott at the Manhattan Railway Company's power house in 1902, which was fully recorded in the December, 1902, issue of POWER, showed that the sponge-felt covering was 3 to 4 per cent. less efficient than the magnesia; the sponge felt had the advantage of greater thickness.

These tests were very generally conceded by the engineering fraternity to have been carefully made and quite reliable.

H. N. DAWES.

Boston, Mass.

Trouble with Water Supply System

In reply to Mr. Medcalf's question under the above title in the April 19 issue, I would say that the pump should discharge water to the tank if it will lift the valve and deliver water to the reservoir.

The displacement of the pump in cubic feet per minute is,

$$\frac{3^2 \times 0.7854 \times 16 \times \textit{number of strokes}}{1728}$$

The theoretical discharge is equal to the displacement but the actual discharge is generally less due to leakage and slippage. When the column of water in the discharge pipe is long and the lift moderate, the energy imparted to the water during the discharge stroke may be sufficient to keep the water in motion during all or a part of the return stroke. This is known as negative slippage and under these conditions the actual discharge may be greater than the displacement. The actual work done by a pump is greater than the useful work due to the fact that force is required to overcome friction.

An estimate of the discharge of the pump in question is,

$$\frac{23{,}100 \times 3}{100} = 693 \textit{ pounds per minute}$$

23,100 is the estimated foot-pounds used in actually lifting the water and is 70 per cent. of one horsepower, 30 per cent. being allowed for the friction in the pipes and the inefficiency of the pump and motor; 3 is the rated horsepower of the motor; 100 is the lift in feet.

Experience has shown that for satisfactory work the flow in the suction pipe should not exceed 200 feet per minute and that in the discharge pipe should not be greater than 400 feet per minute. Therefore, it is important to provide a suction pipe of proper diameter.

JAMES E. NOBLE.

Toronto, Canada.

Novel Feed Water Heater

I read the article by R. S. Seese on "A Novel Feed-water Heater" in the April 19 number. I think that his illustration shows a poor arrangement. He claims to deliver 205-degree water to the boiler. He surely does not take the water from the top of the tank, pass it through the exhaust pipe and then through the pump into the boiler. If he does, the pump must be, indeed, a good one to lift water at that temperature, such a distance.

I do not think that Mr. Seese's arrangement is practicable at all; he has neglected to provide for the oil in the exhaust steam.

RICHARD SCHREIBER.

Albuquerque, N. M.

The Operating Engineer

In the May 3 issue there appeared, in the last column of the editorial section, a short note regarding the proposed Institute of Operating Engineers. How many who saw it wrote for more information as POWER suggested? The address of the provisional organization's secretary was given so that those who are interested could get in on the ground floor; in fact, POWER has done everything except write and post the letters for them, so it is up to the operating engineers now to make the next move.

As was stated in the editorial, the proposed institute will offer more advantages to the real engineer who graduated from the scoop and the oil can than has ever been offered to him before, and any capable engineer will probably miss the opportunity of a lifetime if he fails to look into the matter.

We have our societies to educate us and to make our life more gladsome, but they do not affect any one body as the one proposed. As we well know, too much cannot be accomplished to better conditions which are not the best considering the theoretical and practical knowledge which we must have and the responsibility which we must assume.

Let us get together and make this proposition a success from the beginning. Let us work hard for the largest charter membership of any organization in existence, so that we can look back with pride upon it, as we see the order grow as the years roll by.

Considering the number of operating engineers in this country, the organization should, in a short time, become the greatest of its kind in the world. As the first convention is to be held in the early part of June next, no time should be lost to get in line. You have nothing to lose and everything to gain, and if those who can spare time and money will attend the convention they will be doing the engineering profession a great benefit and thus take another step toward placing it in its proper position.

To know that L. C. Jurgenson, of the engineering department of the Hotel St. Regis and of Columbia University, is the proposer of this organization, should be enough to induce all to "get into the swim" and make it the success it deserves to be.

So, Mr. Engineer, do not hesitate longer; drop Mr. Rice a line at once for full particulars.

Knoxville, Tenn. F. W. FISCHER.

Boiler Inspection

In this advanced age of engineering progress it is seldom that we hear, from the really informed, any expression of hostility to boiler inspection and insurance. Mr. Woodworth, in the May 3 issue, tells how trouble occurred even with competent and experienced inspection. This may, by some, be eagerly pounced upon as an argument against insurance and inspection. To them we can say that in all human affairs the "personal equation" is a factor. It only emphasizes the truth of the old adage, "Constant vigilance is the price of safety."

The following experience will give the critics another view of the insurance question with its advantage of periodical inspection by expert men who are specially trained:

I was once employed by a company which did not believe in boiler insurance and was sent to overhaul one of its numerous water works. Before I had been on the job long enough to get acquainted the water column on the No. 1 boiler became an object of suspicion. The pipes seemed to be of ample size and properly connected, but no blowoff was attached to the column. Examination disclosed the fact that the water connection had been reduced to ½ inch where it entered the boiler and that the steam connection taken out of the top of the boiler was a ¼-inch pipe behind the fronts. The boiler was cooled down immediately and the ¼-inch pipe was found to be almost entirely choked with burnt mud and scale. No. 2 boiler was afterward found to be in the same condition.

The fireman was asked why he carried three gages of water in No. 3, which was a larger boiler. He did not know of any reason except that he had been told to do so. The smoke arch was opened and this column also was found to be connected by a ½-inch pipe. A straight-edge and level were called for and it was found that with 10 inches of

water in the glass the top row of flues was barely covered.

When asked how often he blew the boilers down, the fireman stared a moment and then remembered that the blowoff had been removed by order of the chief engineer three years previously.

Further external inspection showed two large patches over the fire under two of the boilers. The brick settings were found to be tumbled over against the boilers in a dangerous condition.

In No. 3 boiler, beginning amidships and tapering toward the back head, was found from 1 to 10 inches of mud and scale, and at the extreme back end it was piled up to the top row of flues.

All that saved these boilers from destruction was the fact that they were not very hard worked.

When the work on the boilers and settings was completed the daily records showed a saving in coal of over 60 per cent. As this sort of thing had been going on, in a greater or less degree, for seven or eight years, the saving that might have resulted had an insurance inspection disclosed the real condition of the plant early in the game, is evident even to the most biased minds.

There was little difficulty in convincing the company of the desirability of boiler insurance after this and they now carry insurance on all their boiler equipment.

HOMER C. FIELDS.

Yazoo City, Miss.

Engineers' Wages

There has been some discussion in POWER during the last few months concerning the engineer and his pay. Many opinions have been offered as to how much he should receive and how to get it. Some advocate license laws and others unionism as the best medium through which to gain reasonable pay and hours.

Either means is perfect or nearly perfect in theory. In practice, they might improve conditions for some, temporarily at least. But considerable time would be required in either case to produce any material results. Something might be accomplished in three years or it might take thirty years.

An interested engineer, in three years, would spend a large portion of his time in reading, thinking, and talking of things pertaining to the project he favored, be it a national license law or a national or international union of engineers.

Suppose an engineer spent that amount of time, energy and gray matter in increasing his ability and efficiency as an engineer and bringing the results to the notice of his employers. I think that in that way he would increase his pay more than any license law or union could. Furthermore, he would be in better position to qualify for greater increase later on. If his employer is a modern business man he will not let a good man go because of a few dollars' difference in salary.

What every uptodate business man wants, is looking for and will pay for, is anything that will increase the dividends or profit of his business, be it a system, a man, or a machine, and he will pay for it in proportion to its earning power, or, as in many cases, in proportion to the advantage it gives his business over that of his competitor.

W. E. BERTRAND.

Upper Darby, Penn.

I have been interested in the engineers' wage question. I agree that the hours are usually long and the compensation is small.

Often we find that a company does not employ good men and the compensation is all that the men are worth, regardless of the size of the plant. If an engineer is competent to manage a quarter of a million dollar plant he does not have to work for $90 per month, for an engineer of that ability can get at least a 25 per cent. better salary. Engineers who have built up reputations for themselves do not have to work for less than $100 per month, and not very long for that. In order to increase the salaries of the better engineer it is up to them to advertise their abilities and create a demand for their services. They may do so by attending the engineers' associations and taking an active part in the discussions and the educational work; and if they find a brother engineer who is in trouble, visit his plant, locate his trouble and help him out. They can get indicators to help locate troubles, and it will not be very long before employers will be seeking their advice on engineering problems and the results will be a demand for their services.

If an engineer isolates himself in some village or lumber camp he may become an expert through study and practice, but no one knows it except his employer and the result is that there is no demand for his services.

Mix with the engineers and employers and if your abilities are O. K. there will be a demand for them.

When it comes to educating the employer we have got to use figures, dollars and cents; nothing else will appeal to him. If you can show a saving in the power department, put it up to the "Old Man" and in nine cases out of ten he will appreciate it and give you an increase in your salary. Do not stop there but try to cut down expenses and make every year look better than the previous one and your salary will grow in proportion to the saving made, providing you do not meet the type of a man our friend did in Mexico. In such cases an engineer should not waste any time. I have found that a half dozen changes generally bring such men to their senses.

As I said before, advertise your abilities, produce a kilowatt or horsepower-hour for less money than any engineer in your city does under like conditions and there will be no trouble getting more money.

J. H. MORE.

Milwaukee, Wis.

Trouble with a Water Column

My idea of the trouble Mr. Woodworth speaks of in May 3 issue, is this:

The steam connection to the column was too low and very likely it had become submerged several times. In case there was any oil in the water, the pipe would become coated with it, thus providing an excellent condition for the accumulation of scum or slush floating on the water, which would be continually tossed upward and into the pipe by the violent agitation of the water, due to boiling. The oil and slush would become baked in the pipe and in time completely close it. Opening the blowoff from the column would have very little, if any tendency to remove it unless the lower connection were closed while blowing. In fact, the obstruction could not be blown out at all, after once baking fast. With a connection leading from the top of the boiler is the correct way in which to pipe the column, it seems to me.

JOSEPH STEWART.

Hamilton, Ohio.

Cylinder Lubrication

We carry steam at 160 pounds pressure and at a temperature of about 450 degrees Fahrenheit, which means a superheat of about 85 degrees Fahrenheit.

In the 40-inch high-pressure cylinder of a vertical cross-compound engine with a piston speed of 900 feet per minute, we use about four gallons in eight hours of a high-grade cylinder oil costing 35 cents per gallon.

The engine has a riding cutoff with a shaft governor and gridiron valves. The engine being of the four-valve style, including the riders, there are six valves to lubricate. The 84-inch low-pressure cylinder has the same equipment. About half the amount of oil is used in the latter cylinder.

Beside this engine, we have a vertical cross-compound machine the cylinders of which are 42 and 87 inches in diameter, respectively. The piston speed is 750 feet per minute. The high-pressure side is equipped with quadruple-ported poppet valves and the low-pressure side with double-ported Corliss valves.

We use about two gallons of oil in the high-pressure cylinder and about four

gallons in the low-pressure cylinder of this engine.

A receiver pressure of 15 pounds is carried for each engine

G. B. LONGSTREET.

Somerville, Mass.

Transmission of Power by Belts

The article by Mr. Krall, in the May 3 issue, interested me for two reasons: One reason is because steel belting is an interesting thing and the other is because the assumption is made that the second method of driving by belt is a foreign invention.

There is a question in my mind whether a steel belt will cost less for repairs than a leather one. Whether a belt will stand without continually breaking is a question of design.

It is well understood, but seldom remembered, that steel or iron when bent so as to take a permanent set is weakened. The strength that it originally had may be restored by a long rest or by annealing. A running belt gives little chance for applying either remedy; therefore we should be careful that the elastic limit of the material is not exceeded. There is little danger on a direct pull between pulleys of approaching the elastic limit, but when the belt runs around a pulley which is too small the bending alone, without any transmission of power, may be enough to break the belt.

The stress in the outside of a steel belt is easily computed. Let t represent the thickness of the belt in inches and r the radius of the pulley. The circumference of the pulley is

$$2\pi r$$

At the center of the thickness of the belt the circumference is

$$2\pi\left(r+\frac{t}{2}\right)$$

and at the outside of the belt

$$2\pi r + 2\pi t$$

The difference between the first and second and the second and third is πt.

We will write the familiar equation,

$$\frac{p}{E}=\frac{e}{l}$$

in which p equals pull per square inch, E equals modulus of elasticity (30,000,000 for soft steel), e equals elongation (total), and l equals length of stretched part in inches. The ratio of the amount of stretch to the length is $\frac{e}{l}$. Considering that the stresses induced by bending the belt around the pulley are in addition to those produced by the transmission of power we ought not to expect to use over 10,000 pounds as the value for p. Then we have,

$$\frac{10{,}000}{30{,}000{,}000}=\frac{\pi t}{2\pi\left(r+\frac{t}{2}\right)}$$

The ratio of allowable fiber stress due to bending to the modulus of elasticity is equal to the ratio of the thickness of the belt to the modulus of elasticity. In this case, the thickness of the belt should not be over $\frac{10{,}000}{30{,}000{,}000}$ or $\frac{1}{3000}$ of the diameter of the pulley. This allows us a belt 0.01 inch thick on a 30-inch pulley and 0.001 inch thick on a 3-inch pulley, which may lead us to believe that the use of steel belts is limited to large pulleys. Moreover, the form of splice suggested is not adaptable to pulleys of widely varying sizes. This limits the use of steel belts to cases where there is but little change of speed.

Referring to the Lenix system, many New Englanders will recognize it at once as a part of the system long used hereabouts. It simply depends for its efficiency on getting as much wrap on the small pulley as is possible and enough on the large pulley to make the pull equal on both. The theory on which this system depends is that the difference in tension in the two sides of a belt increases a great deal more rapidly than the angle of wrap. If a belt has 270 degrees of wrap on a pulley, it will transmit a considerable amount of power with no tension except that due to its own weight. This principle is worked out in most of the textbooks on mechanics and is taught in all of the technical schools and immediately forgotten.

E. F. HENRY.

Worcester, Mass.

Best Vacuum for Reciprocating Engines

In the May 3 issue, C. H. Wilbur asks which is better for a reciprocating engine, a 26-inch or a 29-inch vacuum. As the plant which Mr. Wilbur has in charge is not so arranged that the coal consumption of the boiler can easily be obtained, he took indicator diagrams at 26-inch and at 29-inch vacuum, and found that there was a gain for the 29-inch vacuum of about 4 to 5 per cent.

Certainly no one will deny that from the same amount of steam, more power can be obtained when the engine is working against a 29-inch vacuum than when working against a 26-inch vacuum. But if we consider the over-all efficiency of the plant, we will find a different state of affairs. To obtain a vacuum of 29 inches much larger condenser and pumps must be used than for a 26-inch vacuum. Also, the amount of condensing water required will be considerably greater and the power to pump this water and to operate the air pump will be correspondingly greater. After we have balanced the interest on our increased investment and the extra power required to maintain the extra 3 inches of vacuum against the gain in power due to the same 3 inches we shall probably find that the balance is on the negative side or, in other words, we expend more energy in the condenser than we get back at the engine.

It is a problem to determine just what is the most economical vacuum to use. In most cases the degree of vacuum is controlled largely by local conditions. In the majority of plants it seems to be around 27 to 28 inches. Above 28 inches the power expended to maintain the vacuum increases at a much larger rate than the gain due to the increased vacuum, and it is very certain that 29 inches is less economical than a slightly lower vacuum.

JOHN FRENCH.

Washington, D. C.

Chimney Insurance

I read with interest the editorial in POWER relative to chimneys being struck by lightning. The block chimney at our plant has been struck four times by lightning. The old stack was struck three times and was so badly shattered that it was torn down and a new one built. The old stack had no conductor on it. When the new stack was built it was decided to put two conductors and four points on it. At 8.45 p.m. of the day before that upon which the lightning-rod man was to come to erect the rods, a bolt struck the new stack and plowed a furrow down its side from top to bottom and in three places holes were made which were almost large enough for a man to crawl through. The stack was repaired and conductors put on and it has never been struck since, although it has gone through some severe electric storms.

I think that every chimney should be protected by lightning rods for a chimney projects into the air higher than adjoining buildings and is sure to be struck sooner or later. The stack which I have been telling of is 150 feet high and 7 feet in diameter at the top.

OAKS KYGER.

Danville, Ill.

Throw of Eccentric

There are many, and I am one, who will not accept without protest the reply to A. L. R., page 873, in the May 10 issue. The Standard dictionary defines "throw" as "the travel or extent of *reciprocating motion* obtainable, as from a crank, eccentric, or rock shaft; as, 'the crank has a throw of six inches.'" So far as crank or eccentric is concerned, this is as I have always understood it and have, I think invariably, known it to be used.

FRANK RICHARDS.

New York City.

[See Kent, pages 816 and 824.—EDITOR.]

Illinois N. A. S. E. State Convention

Moline, Ill., was the scene of the sixth annual convention of the Illinois National Association of Stationary Engineers, and from the time that City Attorney Bell, representing the mayor, turned the keys of the city over to Fred W. Raven, of Chicago, national secretary, to the dinner at the windup, the delegates and visitors were made to feel that this was the most successful meeting that had been held in the history of the organization. After Mr. Raven's response to the welcome of the city's representative there followed educational addresses by Doctor Udden, professor of natural sciences, Augustana College, and H. S. Dickinson, supervisor of manual training in the public schools of Moline. John W. Lane, of Chicago, editor of the *National Engineer*, closed the morning session with a talk on "Good of the Order."

GROUP OF DELEGATES AND VISITORS AT ILLINOIS STATE CONVENTION

In his address before the assembled delegates, Doctor Udden gave an interesting outline of the origin of coal, in which he showed that most of our coal deposits are ancient swamp accumulations which have been buried under later sediments in shallow seas and transformed by the action of ages into the useful product which is such a great factor in our civilization of today. Such accumulations, he said, are now forming in the dismal swamps of Virginia and North Carolina, in the mangrove and cypress swamps of Florida, and in the coastal marshes of the United States. Vegetable material in such situations is known in some places to be as much as 50 feet in depth. A bed of peat 8 feet in depth contains a sufficient quantity of vegetable substance to make a seam of anthracite coal a foot thick and many of the peat swamps known in the world today, he said, would make workable coal beds of the average thickness mined in Illinois at the present time.

Continuing, he outlined the characteristics of different coals and the circumstances under which they were preserved from former ages for our use today. Many interesting geological facts were brought out in his talk on this subject. Regarding the length of time necessary to form coal, he said it has been estimated that the time required for the growth of enough vegetation to form a single coal seam is 50,000 years. No less time would be needed for the accumulation of the hundreds of feet of other sediments in which we find the coal embedded. Repeating this 20 times for as many other coal beds, we have a period of 2,000,000 years for the growth, accumulation and the burial of the coal in a moderate development of the Pennsylvanian formation in America.

Mr. Dickinson spoke on "Gravity," the subject being only an entering wedge which the speaker used in beginning his address, during which he explained some level-headed ideas which he asked the stationary engineers to indorse. He championed the new school of development in which practical education, that which stands for the bread and butter of the average man, was placed above theoretical knowledge which cannot be made use of without the assistance of the former.

The license committee, consisting of A. E. Reynolds, of Peoria; G. J. Stanson, of Elgin; F. H. Bein, of Rock Island; D. F. Witchman, of Bloomington, and Thomas E. Evans, of Joliet, submitted to the convention a license law which, with some alterations, will ultimately go to the State legislature. The law provides for a chief examiner of steam engineers at a salary of $2400 per year, and ten district examiners at $1500 per year. Examination of all persons who operate any steam boiler in the State to be made by these examiners, who shall also have power to revoke licenses where sufficient cause is shown. Under the proposed law it becomes unlawful for any person in the State to operate a stationary boiler or steam engine or any boiler or steam engine other than railroad locomotives or other engines or boilers exempted, without a license. Violators to be liable to a fine of not more than $50. The law authorizes examiners to charge a fee of $10 for the inspection of a single boiler and $5 for each additional boiler. Inspection of traction engines in incorporated cities shall be made for $5. The fee for examination of applicants for an engineers' license is placed at $10 for first-class engineers, $3 for second-class and $2 for third-class, the renewals to cost $1 per year in all classes. Some changes were made in the draft of the proposed law and the bill was referred back to the committee for final action.

Officers for the ensuing year were elected as follows: W. L. Parker, of Elgin, president; John F. Alt, of Ottawa, vice-president, and W. E. Hill, of Rock Island, secretary-treasurer, Mr. Hill being reëlected. The business session was followed by a 7-o'clock supper in the K. P. club rooms. In addition to the delegates about forty ladies were present. During the eventing there was dancing for the visitors, Stages' orchestra furnish-

ing the music, and a pleasant evening was passed.

Ottawa was chosen as the place of next meeting, Mayor K. F. Farrell being early on the ground with the avowed intention of having the convention meet in his city the coming year. The majority of the convention delegates remained over Sunday, in the afternoon a number of them enjoying a launch ride on the Mississippi river.

Supplymen with their exhibits were well represented; the following were present:

Black Diamond Manufacturing Company, Thomas O. Roucke.

G. B. Carpenter Company, C. A. Elliot.

Crandall Packing Company, F. M. Wheeler, A. J. Coulter.

Dearborn Drug and Chemical Company, O. E. Poole, E. P. Poole, F. C. Gibbs.

Garlock Packing Company, A. F. Meyers.

Greene, Tweed & Co., F. E. Ransley.

Hawkeye Boiler Compound Company, Theodore Brumenschenkel, R. M. Rockfort, J. L. Clark, E. Landenburger.

Jenkins Brothers, H. B. MacLelland.

Keystone Lubricating Company, T. W. Armstrong, Henry Helms.

Lunkenheimer Company, E. P. Gould.

George W. Lord Company, W. J. Townsend.

Lyons Boiler Company, W. P. Lyons.

McMaster-Carr Supply Company, R. H. Rawson.

Martin Grate Company, H. E. Wallis.

Midland Supply Company, A. D. Hathaway.

Moline Heating Company, W. H. Nelson, A. K. McCurdy.

Penn. Oil Supply Company, N. G. Griffiths.

Penn Oil Company, U. S. Wilson.

Practical Engineer, A. L. Rice.

Standard Oil Company, F. A. Whitney.

C. B. White & Co., C. B. White.

The Use of Refrigerating Machinery*

By H. D. Pownall

During the past few years the field of refrigeration has broadened enormously and now includes 143 different uses. The principles of refrigeration and refrigerants are briefly considered

Anyone who has carefully noted the development of the refrigerating industry during recent years has undoubtedly felt astonishment at the progress made in this branch of enginering. Until a few years ago the market for ice-making and refrigerating machinery was limited to those industries in which the use of cold was absolutely necessary to their existence.

During the past five years, however, innumerable other trades have recognized the great advantages resulting from refrigeration and have introduced it into heretofore untried fiields; at the present time there are approximately 143 different uses for such machinery. According to the *Ice and Refrigerating Blue Book* of 1909, there is a total of 16,160 refrigerating machines in the United States, representing a total capacity of 612,919 tons per day of 24 hours, or an average of 31.17 tons per machine. The capital invested in the machines alone is estimated at $25,000,000, while the capital represented in ice-making plants is considerably above $100,000,000.

There is probably no other branch of engineering less thoroughly understood than that of refrigeration. This is partly due to the lack of printed matter upon the subject, which, in turn, is in a measure attributable to the fact that it is a costly procedure to secure accurate data relative to the subject. Up to the present time, notwithstanding the wonderful strides which have been made, the various engineering bodies have failed to reach any definite conclusion as to what shall constitute a standard tonnage basis. The several manufacturers of such machinery, therefore, rate their products according to their own judgment.

Principles of Refrigeration

Mechanical refrigeration depends upon the well known fact that fluids in changing from a liquid to a gaseous state absorb heat, which, in turn, is given off on again resuming the liquid state. These different states are brought about by variation in pressure due to the operation of a vapor pump (compressor) which compresses the gas to a point which will permit its liquefaction. The heat produced by compression is removed by water flowing through a condenser, it being necessary to remove one B.t.u. in the condenser for each B.t.u. absorbed by the gas in evaporating, plus a slight addition due to the heat caused by compression and by friction of the gas in the piping system. The liquid flows from the condenser to a receiver and from the latter through a controlling valve, sometimes erroneously called an expansion valve.

The pressure on the condensing side, when using ammonia as a refrigerant, varies from 125 to 200 pounds, depending upon the size of condenser and the temperature and the amount of water available for condensing purposes. The ammonia, during refrigeration, first flows as a liquid through the controlling valve, where its pressure is reduced from the condensing pressure of approximately 175 pounds to that of the refrigerator, about 15 pounds. The temperature of the liquid flowing to the controlling valve is about 90 degrees Fahrenheit and after expansion is approximately zero degrees. This reduction in temperature is caused by the evaporation of a portion of the liquid (about 18 per cent.), which, owing to its latent heat, cools the balance of the liquid to zero degrees.

The refrigerating fluid is contained in coils of piping or in cylindrical vessels. In an ice-making machine these coils are immersed in a brine solution which is circulated through the system. The brine being warmer than the refrigerating fluid causes the latter to evaporate. During this process the refrigerating agent absorbs from the brine a certain amount of heat, which is conveyed to the compressor, the resultant gas being again raised in pressure and the cycle repeated. Thus the refrigerating agent performs its duty by first taking up heat from the material to be chilled and transmitting it to the water circulated through the condenser.

Refrigerating Agents

Many different volatile fluids are adaptable as refrigerating agents, but those which have proved most practical are anhydrous ammonia and carbonic anhydride. Although the same principle underlies the use of all such fluids, their physical properties vary and consequently demand different treatment to produce the best results.

The ordinary working pressures of the ammonia compression or absorption system are from 15 pounds on the evaporating side to 220 pounds on the condensing side, while with carbonic anhydride these respective pressures are approximately 300 to 1250 pounds.

The Refrigerating Machine

Owing to the peculiarity of the ice-making and refrigerating business, it is essential that nothing but the best grade of materials and workmanship be used in the construction, as such plants often

*Abstract of paper presented before the Ohio Society of Mechanical, Electrical and Steam Engineers.

are required to operate continuously, 24 hours a day, for periods of several months.

There are two general types of machines on the market: the vertical single-acting and the horizontal double-acting machine. The relative merits of the two types have received much discussion, but at the present time it is safe to say that at least 75 per cent. of the machines sold, of over five tons capacity, are of the horizontal double-acting type.

Specific Heat of Superheated Steam*

By D. S. Jacobus

In computing the efficiencies of boilers with superheaters or of engines and turbines using superheat, it is necessary to know the specific heat of superheated steam. Careful experiments have been made along this line by Messrs. Knoblauch and Jakob, of Berlin, and by Prof. Carl C. Thomas, formerly of Cornell University. The results secured by these investigators are very nearly the same, except for high ranges of pressure, and in most cases the error involved through using one or the other value would be within the probable error of the experimental results secured in the test.

In order to place the results of these investigations in a convenient form, A. D. Pratt who has been associated with the writer in testing, made a careful study of the data and has compiled the following table, which represents the average values found by these two investigators, for the specific heat of steam above the saturation point at various pressures and temperatures.

*Excerpt from a paper delivered at the annual meeting of the National Association of Cotton Manufacturers at Boston, April 27-28, 1910.

MEAN SPECIFIC HEAT OF SUPERHEATED STEAM.

AVERAGE VALUES COMPUTED FROM RESULTS OF THOMAS AND KNOBLAUCH & JAKOB.

Gage Pressure—Pounds per Sq.in.	Superheat, Degrees Fahrenheit.															
	50	60	70	80	90	100	110	120	130	140	150	160	170	180	190	200
35	0.532	0.527	0.523	0.520	0.517	0.515	0.513	0.510	0.509	0.508	0.507	0.505	0.504	0.503	0.502	0.501
40	0.536	0.531	0.527	0.524	0.521	0.518	0.516	0.514	0.513	0.511	0.509	0.508	0.507	0.506	0.505	0.504
45	0.540	0.535	0.530	0.527	0.524	0.522	0.519	0.517	0.516	0.514	0.512	0.511	0.510	0.509	0.508	0.507
50	0.544	0.539	0.534	0.531	0.528	0.525	0.523	0.521	0.519	0.517	0.515	0.514	0.513	0.511	0.510	0.509
55	0.547	0.542	0.538	0.534	0.531	0.528	0.526	0.524	0.522	0.520	0.518	0.517	0.515	0.514	0.513	0.512
60	0.551	0.546	0.542	0.538	0.535	0.532	0.529	0.527	0.525	0.523	0.521	0.519	0.518	0.516	0.515	0.514
65	0.555	0.549	0.545	0.541	0.538	0.535	0.532	0.530	0.527	0.525	0.523	0.522	0.520	0.519	0.517	0.516
70	0.558	0.553	0.548	0.544	0.541	0.538	0.535	0.532	0.530	0.528	0.526	0.524	0.523	0.521	0.520	0.518
75	0.561	0.556	0.551	0.547	0.544	0.541	0.538	0.535	0.533	0.530	0.528	0.527	0.525	0.523	0.522	0.520
80	0.565	0.559	0.554	0.550	0.547	0.543	0.540	0.538	0.535	0.533	0.531	0.529	0.527	0.525	0.524	0.522
85	0.568	0.562	0.558	0.553	0.550	0.546	0.543	0.540	0.538	0.535	0.533	0.531	0.529	0.527	0.526	0.524
90	0.571	0.566	0.561	0.556	0.552	0.549	0.545	0.543	0.540	0.537	0.535	0.533	0.531	0.529	0.528	0.526
95	0.575	0.569	0.564	0.559	0.555	0.551	0.548	0.545	0.542	0.540	0.537	0.535	0.533	0.531	0.529	0.528
100	0.578	0.572	0.566	0.562	0.557	0.554	0.550	0.547	0.544	0.542	0.539	0.537	0.535	0.533	0.531	0.530
105	0.581	0.575	0.569	0.564	0.560	0.556	0.552	0.549	0.546	0.544	0.541	0.539	0.537	0.535	0.533	0.531
110	0.584	0.578	0.572	0.567	0.562	0.558	0.555	0.551	0.548	0.546	0.543	0.541	0.539	0.536	0.535	0.533
115	0.587	0.580	0.574	0.569	0.565	0.561	0.557	0.553	0.550	0.548	0.545	0.543	0.540	0.538	0.536	0.534
120	0.590	0.583	0.577	0.572	0.567	0.563	0.559	0.556	0.552	0.549	0.547	0.545	0.542	0.540	0.538	0.536
125	0.593	0.586	0.579	0.574	0.569	0.565	0.561	0.558	0.554	0.551	0.549	0.546	0.544	0.541	0.539	0.538
130	0.595	0.588	0.582	0.576	0.571	0.567	0.563	0.560	0.556	0.553	0.551	0.548	0.545	0.543	0.541	0.539
135	0.598	0.591	0.584	0.578	0.574	0.569	0.565	0.561	0.558	0.555	0.552	0.549	0.547	0.544	0.542	0.540
140	0.601	0.593	0.586	0.581	0.576	0.571	0.567	0.563	0.560	0.556	0.554	0.551	0.548	0.546	0.544	0.542
145	0.603	0.596	0.589	0.583	0.578	0.573	0.569	0.565	0.561	0.558	0.555	0.552	0.550	0.547	0.545	0.543
150	0.606	0.598	0.591	0.585	0.579	0.575	0.571	0.567	0.563	0.560	0.557	0.554	0.551	0.549	0.546	0.544
155	0.608	0.600	0.593	0.587	0.581	0.577	0.572	0.568	0.565	0.561	0.558	0.555	0.553	0.550	0.548	0.545
160	0.611	0.602	0.595	0.589	0.583	0.578	0.573	0.570	0.566	0.563	0.560	0.557	0.554	0.551	0.549	0.546
165	0.613	0.605	0.597	0.591	0.585	0.580	0.575	0.571	0.568	0.564	0.561	0.558	0.555	0.552	0.550	0.548
170	0.615	0.607	0.599	0.593	0.587	0.582	0.577	0.573	0.569	0.565	0.562	0.559	0.556	0.554	0.551	0.549
175	0.618	0.609	0.601	0.594	0.588	0.583	0.578	0.574	0.570	0.567	0.563	0.560	0.558	0.555	0.552	0.550
180	0.620	0.611	0.603	0.596	0.590	0.585	0.580	0.576	0.572	0.568	0.565	0.561	0.559	0.556	0.553	0.551
185	0.622	0.613	0.605	0.598	0.591	0.586	0.581	0.577	0.573	0.569	0.566	0.562	0.560	0.557	0.554	0.552
190	0.625	0.615	0.607	0.599	0.593	0.587	0.583	0.578	0.574	0.570	0.567	0.564	0.561	0.558	0.555	0.553
195	0.627	0.617	0.608	0.601	0.595	0.589	0.584	0.579	0.575	0.571	0.568	0.565	0.562	0.559	0.556	0.554
200	0.629	0.619	0.610	0.602	0.596	0.590	0.585	0.580	0.576	0.572	0.569	0.566	0.563	0.560	0.557	0.555
205	0.631	0.621	0.612	0.604	0.597	0.592	0.586	0.582	0.577	0.573	0.570	0.567	0.564	0.561	0.558	0.555
210	0.633	0.623	0.613	0.605	0.599	0.593	0.588	0.583	0.578	0.574	0.571	0.568	0.565	0.562	0.559	0.556
215	0.635	0.624	0.615	0.607	0.600	0.594	0.589	0.584	0.579	0.575	0.572	0.568	0.565	0.562	0.560	0.557

Tube Rupture Due to Poor Welding

A water-tube boiler furnishing steam for a mill engine at the works of John I. Parkes, Limited, Smethwick, England, exploded a few months ago and resulted in badly scalding the fireman.

The boiler was of the Stirling type, containing four drums—three upper and one lower—each 3 feet 6 inches in diameter and 10 feet long; the upper drums being connected to the lower by lap-welded, wrought-iron tubes, 3½ inches external diameter and about 15 feet in length.

It appears to have been built in 1896, and was designed for a working pressure of 150 pounds per square inch, although at the time of the accident it was under only 100 pounds. At the time of erection it had been tested under a hydraulic pressure of 270 pounds per square inch, and again in 1905 at 225 pounds. Furthermore, during the process of manufacture the tubes had been subjected to a hydraulic pressure of 1000 pounds per square inch, both before and after bending.

The explosion was due to the failure of one of the tubes in the third row at the point indicated in the sketches, Fig. 1. Through the opening thus formed the steam escaped into the furnace and blew through the furnace door, seriously injuring the fireman, who at the time happened to be standing opposite.

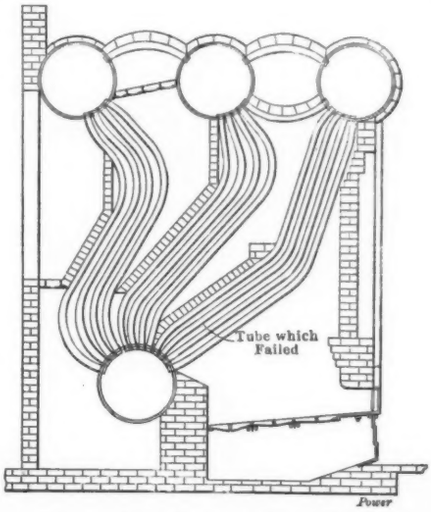


FIG. 1. SIDE ELEVATION OF BOILER

A thorough investigation into the cause of the failure revealed the fact that it was due to a defective weld in the tube. Only on the inside edge where the fracture occurred, had the iron been welded, the material over the remaining portion of the lap, which was about ½ inch wide, being merely pressed together.

FIG. 2. RUPTURED TUBE

A sketch of the fractured tube is shown in Fig. 2.

Having regard to the defective manner in which the tube had been welded, it is somewhat surprising that it did not fail sooner; and no doubt, had the boiler been tested occasionally, to a suitable hydraulic pressure, the condition of the tube would have been revealed.

Inquiries of General Interest

Questions are not answered unless accompanied by the name and address of the inquirer. This page is for you when stuck—use it.

Charging Small Storage Batteries

Can a small storage battery used for gas-engine ignition be charged from a seven-volt generator? If so, how can I tell the positive and negative poles of the generator and the battery, and how should they be connected together?

W. H. K.

The generator will charge the battery if there are not more than three cells and if the generator is a direct-current machine. The positive plates of the battery are rusty red in color and the negative plates slate gray. You can identify the terminals of the generator by means of a compass and a small coil of wire. Wind an oblong coil of wire of about No. 24 gage, making the coil large enough for the compass to be placed within it, and put it around the compass so that the wires across the face lie parallel with the needle. Connect the coil to the generator; if the "north" end of the needle turns to the left, the current in the wires over the dial is running from south to north, and tracing its course to the dynamo will lead to the negative terminal.

Burst Tube in Closed Heater

How can the bursting of a tube in a closed heater be detected, and repaired, and what effect will it have?

J. A. H.

A leak in a heater tube may be detected by putting on a water pressure. If a tube leaks, water will run into the steam space. The particular tube leaking may be found by removing one of the heads and filling the steam space with water, which will run into the water space through the leaking tube. Temporary repair may be made by plugging the ends of the damaged tube, and a permanent one by putting in a new tube.

As to effects, it will be necessary to run the feed pump enough faster to make up for the water lost through the break; the feed water that goes to the boiler will not be as hot as before and a great deal of water will go to waste.

Lamps on a Dynamo

An old Thomson-Houston railway generator (500 volts) has five incandescent lamps mounted on its terminal board. Do these act as a field discharge resistance?

L. J. G.

No; a direct-current dynamo does not need a discharge resistance because it is not necessary for its shunt circuit to be opened when "alive." The lamps are merely pilot lamps, to show that the machine is generating when it is being brought up to voltage for connecting to the circuit.

Bags on Boilers

What causes boilers to bag and where are they found?

J. H. M.

Bags usually occur on the bottom of the second course just back of the first seam. They are caused by overheating while the boiler is under pressure. Loose scale or oil that has picked up enough mud to make it heavier than the water is carried by the circulation toward the front end of the boiler where some of it is caught by the rivet heads, forming a sort of dam against which more stuff of the same sort accumulates until there is enough to prevent the water from reaching the shell as fast as it evaporates; the sheet becomes dry, is softened by the heat until the pressure stretches it into a bulge called a bag.

When the sheet stretches, the obstructing mass is usually so disturbed that the water finds a way through it to the shell which is cooled and the stretching ceases.

Bags usually happen at the beginning of a run. During a period of hard firing the circulation is rapid enough to carry everything in the water over the rivet heads, but as the circulation drops off as the boiler cools, the sludge is easily arrested, because the circulation is slow; and when the fire is again forced, more has accumulated than the current of water will move.

Many boilers have bagged just after the noon-hour rest, and many others just as the load was going on for the day.

Maximum Allowable Pressure

How is the allowable pressure on steam boilers determined?

J. H. M.

The Massachusetts Board of Boiler Rules says:

The maximum pressure to be allowed on a boiler constructed of steel or wrought-iron shells or drums shall be determined from the minimum thickness of the shell plates, the lowest tensile strength stamped on the plates by the plate manufacturer, the efficiency of the longitudinal joint or ligament between the tube holes, whichever is the least, the inside diameter of the outside course, and a factor of safety of not less than five; the formula being:

$$\frac{T.S. \times t \times \text{per cent.}}{R \times F.S.} = (\text{maximum allowable working pressure per square inch in pounds})$$

$T.S.$ = Tensile strength of shell plate in pounds.

t = Minimum thickness of shell plate in inches.

Per Cent. = Efficiency of longitudinal joint or ligament between tube holes, whichever is the least.

R = Radius = one-half the inside diameter of the outside course of the shell or drum.

$F.S.$ = Five, the lowest factor of safety allowed on boilers installed after May 1, 1908.

Change of Lead

If a valve with a riding cutoff had ¼-inch lead at one end and the other end was right, how could the lead be regulated?

P. C. D.

The riding cutoff has nothing to do with lap, lead or compression. Its one function is to cut off the steam at a certain point in the stroke. In the case mentioned, the length of the valve stem should be altered until the lead of the main valve is the same at both ends of the stroke; then with the engine on the center the eccentric should be turned until the lead is right.

Erratic Behavior of a Shunt-wound Motor

A shunt-wound direct-current motor runs in the same direction regardless of the connections of its field winding; what causes this?

C. C. McI.

If the connections between the main motor terminals and the supply circuit are reversed without changing the relation between the armature and field winding leads, the motor will run the same way as before, because the current is reversed in both the field and armature windings when the main connections are reversed. If the main connections are not disturbed but the connections between the armature and field windings are reversed, and the motor continues to run the same way, then the field circuit is open and the machine is running on a field due to strong residual magnetism.

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Power and The Engineer

Editorial

Heat from Combustion of Water

Every little while some half-informed person proposes anew the idea of getting heat from burning the hydrogen which is one of the constituents of water. Hydrogen has a very high calorific power, and will give up a large amount of heat. Water can be cheaply gotten in most places; if we can only dissociate the hydrogen from the oxygen and set fire to it, we will heat a large volume of water. This is the basis of the scheme; and it usually lurks in the minds of those who would use a dampened fuel, or who would have a flooded ashpit under the grates from which a certain quantity of steam will be vaporized and pass up through the bed of fuel.

The basal difficulty which is met in the bold scheme of water-burning is that due to the scientific fact that to dissociate water into its constituents of hydrogen and oxygen takes or absorbs in the process exactly the same quantity of energy in the form of heat as is subsequently given out when the process is reversed, an hydrogen unites again with oxygen to form the vapor of water as the product of combustion. If it is desired to cool the fuel bed, as is sought in the gas producer making water gas, the demand for disscciation of water is a very effective means to do this. If the temperature of the fuel bed is low enough so that no recombination takes place, in the producer, the hydrogen gas goes with the carbonic-oxide gas to the point where the ignition temperature is maintained—in the furnace or other point where the heat from the gas is desired. But if the recombination is desired at the fuel bed, as in a boiler furnace, for example, then the incandescent coal on the grates is cooled by the steam just as much and t the same degree as the temperature is raised by the burning of the hydrogen. The effect has been to retard the combustion of the coal, and this is ordinarily undesirable. So far as steam making is concerned, the water has done neither good nor harm. If the grate is too large, or the flame from the coal is short, as is the case with anthracite, it may be of a sort of mechanico-thermal advantage to introduce hydrogen into the burning elements, whereby a long flame characteristic of hydrogen will be mixed with the shorter carbon flame. The intense local heat of the anthracite fuel bed may be lessened sometimes with advantage. But steam in a bituminous fire does not offer even this debatable advantage, and is entirely inert, unless it bring with it in mechanical admixture a proportion of air for combustion, at the right temperature and at the right place and time.

These points have been brought up by a recent contribution to engineering data and knowledge in the form of a paper reporting tests of boilers using wet tanbark as a fuel. In the tanneries of the country, after the tanning extract has been removed in a leaching process, the spent tan has considerable calorific power as wood, and is usually brought to the boiler room to be utilized in the furnaces. Dry hemlock tanbark has the evaporative capacity of 42 per cent. of the same weight of good coal of 13,500 heat units. The wet bark carries 65 per cent. of water by weight. The tests in question gave a thermal efficiency of 71.1 per cent. based on the available heat in the fuel.

It must be observed, however, that these results are not secured without care, nor in disregard of certain important details of design. If the supply of wet fuel is in excess of the capacity of the furnace to dry and burn the tan, the incandescent fuel bed is unable to raise the temperature of the new charge sufficiently, or is itself unduly cooled. Hence the generation of steam is checked for the moment; and worse than this, the temperature of the furnace falls below the point at which the gases are distilled from the wood in readiness to ignite. The results are fuel losses in unburned gases, or a smoky, cool flame. On the other hand, of course, if too little fuel is fed to the fires, the well known difficulty is met which happens in all very small fuel whose particles burn quickly. The fire surface becomes full of holes where burnt-out areas are, and through these holes cool air rushes up from below, impinging against the shell or cooling the gases by diluting them with excess of air.

In a type of furnace which has proved most successful in avoiding these difficulties, the designer has used two step grates, facing each other, and with their length parallel to the axis of the horizontal boiler. The step grates lessen the difficulty from holes in the fire; and yet an abundant supply of air can be se-

cured for a high rate of combustion and its attendant hot fire. By putting these facing grates in a dutch-oven type of furnace, the heat of the roof is reverberated down upon the fresh wet-fuel charges. By the inclination of the grates as a whole made up of the stepped bars, the thickness of the fuel bed is kept under stated control, and if mechanical stoking is applied also, there is little danger from irregular feeding. It is the successful maintenance of the igniting temperature under the arch of the oven furnace that is the secret of complete and reasonably smokeless combustion; it is the menace of the moisture in the fuel that it tends to lower the combustion surface of the fire below this temperature. It is very wise also to remove the boiler shell from the furnace proper, since its temperature should always be less than the igniting point of the gases given off from the wood, and it will tend, if too close to the flame surface, to refrigerate and extinguish the flame after combustion is only partially completed.

The Canton Boiler Explosion

In his report to the coroner, our Western editor did not believe that the stays in the boiler which exploded at Canton, though fifteen years old, were a serious factor in the explosion. His conclusion was based on the following data:

The distance from the top of the tubes to the shell was twenty inches, and after deducting a space of three inches around the edge of the segment adjacent to the shell and a strip two inches wide along the top row of tubes, according to standard practice, there remained an unsupported area of 553 square inches, which at one hundred pounds gage pressure per square inch must withstand a total pressure of 55,300 pounds. This area was supported by twelve diagonal stays of one-inch cross-sectional area, so that each stay would be subjected to a tension of 4608 pounds, which would give a considerable margin for depreciation before taxing the metal up to the allowable stress of 6000 pounds per square inch. When it is taken into consideration that this latter stress is figured on a factor of safety of four, based on one-half the ultimate strength of the material, it can be seen what a large margin of safety is actually allowed in the ordinary design of diagonal stays. Had the material of which the stays were constructed been of 60,000 pounds tensile strength, the allowable stress per square inch would have been 7500 pounds, and this factor is taken by some authorities for stays above the water line. The above figures, of course, do not take into consideration the resistance of the head itself, which, in view of its excellent physical condition, would be considerable.

Action is equal to reaction and in an opposite direction; so had either head let go first it would be reasonable to suppose that the direction taken by the boiler would have given some indication of the fact. Similarly in the longitudinal seams, if the left-hand seam looking from the front had given way first, the reaction should have thrown No. 2 boiler over on to the others in the battery. However, all information indicates that the energy within the boiler was expended equally in all directions, throwing No. 1 boiler on the one side and No. 3 boiler on the opposite side away from their settings with approximately equal force. They were both full of water and under steam, and No. 1 boiler, being at the end of the battery, was naturally thrown farther, the force of No. 3 being used up in knocking some of the adjacent boilers from their foundations.

In view of the testimony of the water tender that No. 2 boiler was cut in at the time of the explosion, it becomes necessary to assume another set of conditions by which the boiler might have been "set off," and yet conform to all of the known conditions surrounding the accident. The only other possibility which comes to mind is that the nipple under the safety valve, which had been leaking the day before, again started to leak, and that the fireman was attempting to calk it when the nipple blew out.

Most of the theories advanced as to the cause of the explosion are necessarily long-range decisions made by people who were not present at the time and based on such evidence as has been possible to get together. It would seem, however, to require the bringing forward of additional facts, that have not yet been brought out, in order to deduce a more reasonable explanation of the accident.

Invention as a Degradant

Despite the notable illustrations of inventors who are good business men, it is still true that the typical inventor is from necessity often open to exploitation by the capitalist; but so is the capitalist open to exploitation, and the wise capitalist keeps an expert to protect him. But the tendency of invention to degrade the inventor and make him into a tricky adventurer with all his adroitness has not been sufficiently recognized.

The most pronounced case that has come to the knowledge of the writer was that of a business man who desired, let us say, to lubricate car axles with gravel. That was not what he really undertook, though his idea was after all as illogical though not so evidently preposterous. To be sure, there once was an engineer in the navy who actually fed mud into his bearings and was not courtmartialed, but the inventor did not know that, for, as we have said, he did not really use gravel.

This inventor, who was well fed, well dressed, and evidently in his right mind, consulted a professor to see if he could not rig up an experiment that would prove his idea; in fact, he consulted two professors who tried greatly to dissuade him, but who pointed out that trying the real thing would not be very expensive. So he did, and his idea passed on.

Now this inventor was not to be exploited, being a business man himself. He apparently paid for his venture himself; at any rate some months afterward he came up again with an utterly impossible invention, at least as bad as sand for a lubricant. And he was shabby and ill kept. He had also lost his manners, for when the professor refused to be a party to any séance of that sort he became abusive, and it was fortunate that the professor was young and able bodied. Here was the beginning and the end; but after all he may not have been a real inventor, because he did not really invent anything.

The same result was seen in the end of a real inventor, one who had invented valuable things. He greatly desired to burn kerosene in an engine so that insurance inspectors should not make trouble. He finally interested several young men who provided the means. All summer he worked where they all could see that he burned kerosene, and only kerosene, till they found that drop by drop he was also feeding naphtha. Then he complained to the writer that they lost faith and dropped out; in the same breath he chuckled to think how he had fooled them all summer.

That an inventor may be guileless is illustrated by a young man who so far anticipated the recent successes of aviators as to recognize that business instinct was part of the proposition. But at that time the pioneers, if not without expectation of financial reward, were without immediate prospects. He was going to succeed because he saw that the proper idea was to work the thing so that he could make money. What he had in mind was not enough to begin flying with, so he went into the stock market with the idea of making money. The reader can supply all the details that may seem proper for the occasion.

Invention, as a career, seldom proves profitable, and it may not be out of place to caution the young man of ingenious mind to be on the alert for the pitfalls which strew the path of the inventor.

Why does most every inventor of a rotary engine dream aloud and publish his photograph as a frontispiece to his prospectus?

"Keep to the right" is a good motto—except when you are cutting a left-hand thread.

A natural mechanic is a man who does a thing in the best way, the first time.

Each call of the salesman means a cheap cigar.

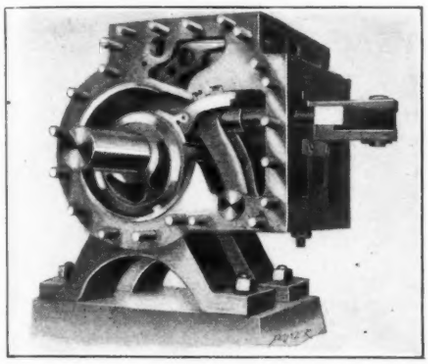
New Power House Equipment

What the inventor and the manufacturer are doing to save time and money in the engine room and power house. Engine room news.

The Kinney Positive Pressure Rotary Pump

The Kinney pump as described by C. O. Thurston at the Ohio Society convenvention, consists of a cylinder having a suction inlet, a discharge outlet and a central shaft to which a rotor is eccentrically keyed, so that it engages the inner surface of the outer cylinder.

A shoe separates the suction and the



KINNEY ROTARY PUMP

discharge sections. In some of the smaller pumps the shoe is kept in contact with the rotor by a spring, but in the larger two-cylinder pumps the shoes are yoked together 180 degrees apart, thus making a spring unnecessary.

Wiping rings are placed on the ends of the rotors to lessen the friction. As the rotor is turned the liquid is drawn in behind it and pushed out before it, the rotor acting as a rotating piston.

In the single-cylinder pump there is a slight impulse to the discharge as the rotor drops its load for an instant while passing the open ports, but, as these pumps are always small and usually run at a fair speed, an air chamber makes this nearly unnoticeable. Where two rotors are used and set opposite, or 180 degrees apart, as in all of the larger pumps, the discharge is steady.

With a dry or unprimed pump water has been lifted 21 feet, and with a primed pump a lift of 33.1 feet at Boston or sea level has been attained. Being a positive pump the hight to which a liquid can be forced is limited only by the force at command.

The table gives a report of two tests made by the Tide Water Oil Company.

As a water pump it has the positive action of the piston pump, and being without valves combines this with the advantages of a rotary. It is not adapted to deep-well work or to dredging, though grit in suspension gives it no serious trouble.

It is especially adapted to handling those heavy, sticky liquids that give endless trouble to pumps having valves, and to those propositions where power is desired united with compactness, lightness and freedom from noise and vibration. The pump is now handling successfully coal, tar, molasses, caramel, fruit syrups, oil of different grades, soap, tanning extract, etc. It is also being used in elevator work, as a fire pump, as a spray pump, and for a variety of domestic uses.

The pump easily compounds, giving greater pressure with the same power, and at the same time greatly increasing the proportionate volume.

TEST OF BELT-DRIVEN KINNEY ROTARY PUMP.

	Test No. 1.	Test No. 2.
Date	Feb. 21, 1910.	March 3, 1910.
Duration of test in hours	1	1
Revolutions per minute	250	355
Horsepower to operate motor, shafting, etc., without load	5.4	6.6
H.P. to operate motor, shafting, etc., with load	8.0	11.2
Gallons oil at 60° F. pumped per hour	18,500	26,400
Weight per gallon in pounds at 60° F	6.677	6.669
Discharge pressure in pounds	9.0	9.25
Suction head in pounds	5.0	3 5
Oil horsepower	0.719	1.480
Actual horsepower	2.6	4.6
Per cent. efficiency of pump	27.66	30.83

Pump, 10 inches diameter, two rotors each of 6-inch face, drop 1½ inches, weight 2400 pounds, 4-inch shaft, two out-board bearings, rocker action.

Motor used, 30-horsepower, 850 revolutions per minute.

"Newtype" Water Gate Valve

This type of valve is a radical departure from the type the Kennedy Valve Manufacturing Company, Elmira, N. Y., has heretofore manufactured. It is suitable for use on water mains connected with the steam plant.

This valve has double wedging mechanism, parallel seats and an independent stem nut, with a straightway passage the full diameter of the connecting pipe.

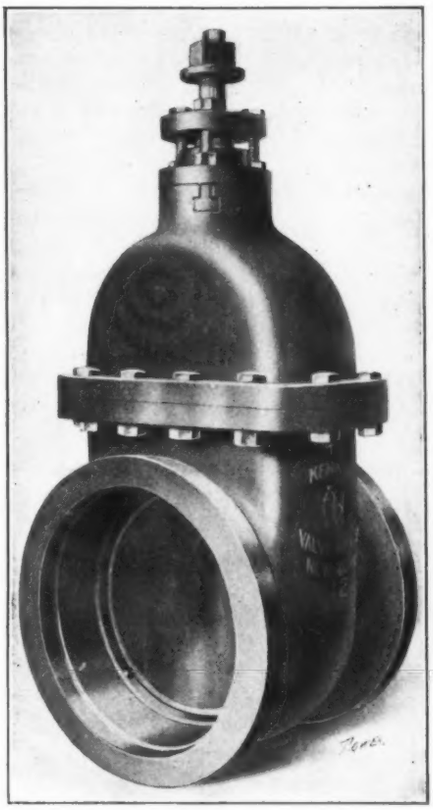


FIG. 1. SHOWING DISK SEATED AGAINST RING

The parallel faces of the seat and disk rings move so closely upon each other that all foreign matter that may have col-

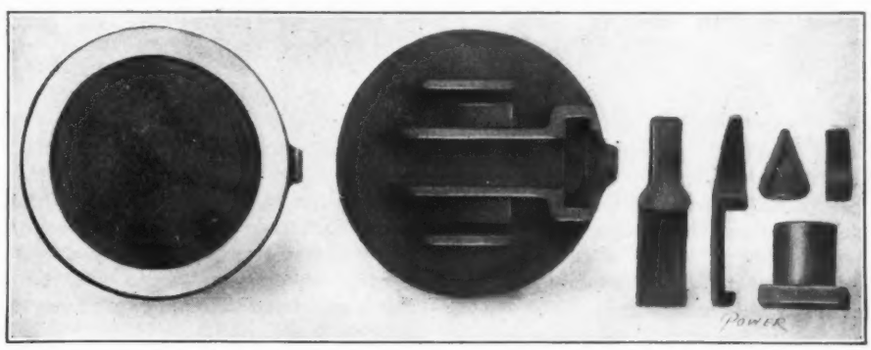


FIG. 2. PARTS OF DISK ARRANGEMENT

lected on the rings is scraped off, allowing even contact of the seats and disk rings. The valve works equally well with either disk toward the pressure.

The disks, in closing, move to their position opposite their ports, then close squarely against them. The wedges are of solid bronze and act on both disks equally and independently of the stem, which prevents the stem being thrown out of alinement. The wedging surfaces of the wedges are of the same angle, thus making them interchangeable, and have a free lateral movement between the disks. Fig. 1 shows the disk seated against the disk ring.

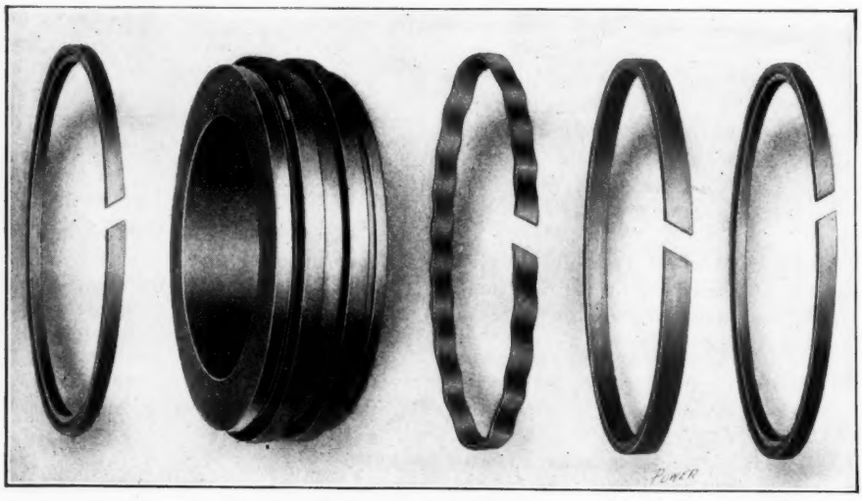
In opening the valve, after the first movement of the stem, the disks release automatically. The bronze stem nut, through which the stem revolves, is loose and separate from the disks and cannot be forced out of central lines by the action of the wedges.

One side of this stem nut is thicker than the other, so that, in opening, one disks lifts ahead of the other, and consequently draws one wedging face directly away from the other, making it impossible for the disk to stick. The design of the disks is shown in Fig. 2.

The body, cap, stuffing box and gland are made of a mixture of cast iron. The other parts are of bronze.

Kilroy Automatic Adjusting Piston Rings

This type of packing ring is made by the Kilroy Piston Ring Company, 74 Cortlandt street, New York City. The illustration shows the various rings, spring and bull ring which constitute the complete piston.



KILROY PISTON RINGS

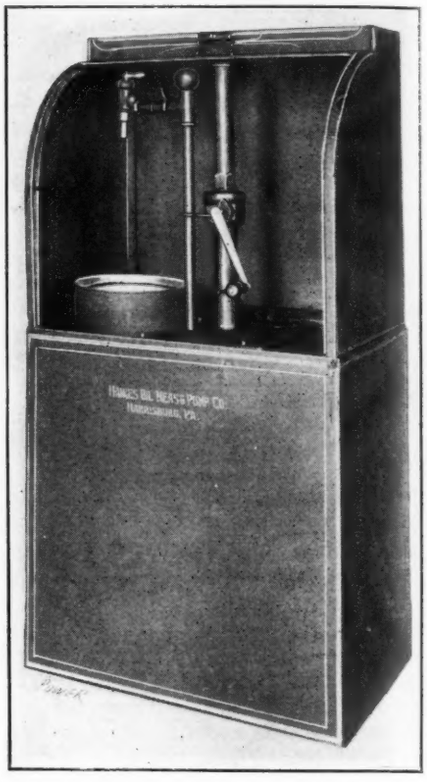
Referring to the illustration, the construction of this packing ring will be readily understood. At either end of the piston head snap rings are fitted into grooves turned in the piston head or bull ring. These rings are so constructed that there is a steam gap between the flange of the ring and the face of the piston head or bull ring. The pressure enters this steam gap and expands the rings to the full diameter of the cylinder wall. The rings are prevented from turning by a small pin which projects from the bull ring and travels in a short slot cut in the back of the packing ring. This pin allows play for the ring to expand in any direction and prevents it from turning or changing its position. The center ring is of the usual design of snap ring and is pressed against the cylinder walls by means of a corrugated spring placed underneath.

The ring nearest the pressure is expanded when the piston is traveling in either direction, and it is claimed that the friction which would be developed from the forward and return stroke is greatly reduced, as there is but one ring at each stroke actually in operation or bearing to any extent against the wall of the cylinder. The office of the central ring is to help carry the weight of the piston to steady its motion.

The installation of this type of ring in any engine may be effected by removing the old, and installing a new piston fitted with Kilroy rings.

A Dust Proof Oil Tank with Self Measuring Pump

The halftone shows an oil tank, built by the Haines Oil-Measuring Pump Company, Harrisburg, Penn. The tank is made of heavy galvanized sheet steel, and of any capacity desired, the one shown being able to accommodate about 70 gallons. The pump is of the self-measuring type. In the small size one turn of the handle delivers one-half pint of oil at the nozzle, and in the large size, one quart is delivered per turn of the handle. The pump is made of seamless brass tube and the valves are of brass. No rubber, leather, or other packing affected by oil is used in the construction. All working parts are inclosed and a roll top is provided so as to exclude dust. The same concern makes a variety of storage tanks for oil or gasolene equipped with self-measuring pumps.



SELF MEASURING OIL TANK PUMP

Arrangement for Extracting Air from Condensers

In condensers and more especially in jet condensers it is necessary to extract the air from the main condenser very thoroughly. According to the *Mechanical Engineer*, of London, an arrangement for

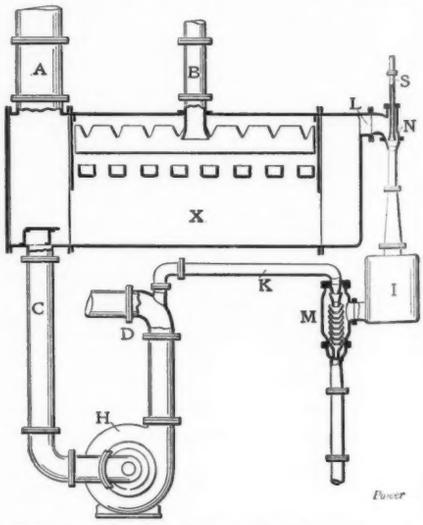


FIG. 1. ARRANGEMENT FOR EXTRACTING AIR FROM A JET CONDENSER

this purpose has been patented by Willans & Robinson, Limited, and E. G. Izod, Victoria Works, Rugby, in which the water from the lower part of the main condenser is drawn off by a centrifugal pump, and the air and vapor from the upper part of the main condenser are drawn off by the action of a steam jet supplied with live steam and discharging into a receiving chamber, within which a

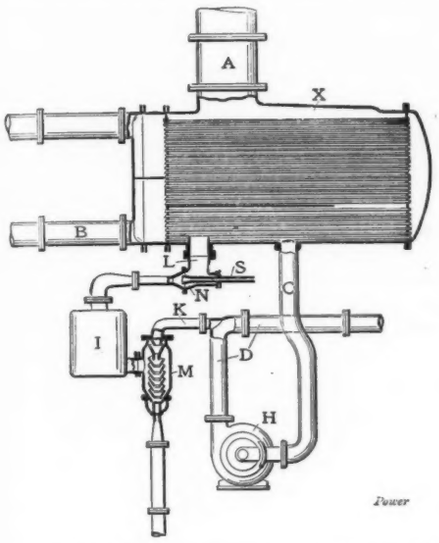


FIG. 2. ARRANGEMENT FOR EXTRACTING AIR FROM A SURFACE CONDENSER

moderate vacuum is maintained by the action of a small ejector condenser supplied with water under pressure by leading off a portion of the water which is being discharged through the discharge pipe of the centrifugal pump. It is necessary that the steam jet should discharge into an enlarged receiver to insure the steam jet working satisfactorily in conjunction with the water jet, as it has been found that if the steam jet discharges directly into the water jet very unsatisfactory results are obtained.

The accompanying illustrations show the arrangement applied to two forms of condenser. In Fig. 1 the main condenser is a jet condenser, and in Fig. 2 it is a surface condenser. *A* is the steam inlet to the main condenser *X*. *B* is the inlet for circulating water. *C* is a pipe led away from the lower part of the condenser through which water is drawn off by a centrifugal pump *H*. *L* is a passage through which air and vapor are led away from the main condenser by the action of a steam jet *N* supplied with live steam through a pipe *S*. *I* is a receiving chamber into which the air and vapor delivered from the jet *N* are collected. *M* is a water-jet condenser by which air and vapor are drawn away from the receiving chamber. Whatever vacuum is maintained at *L*, it is necessary to have a pressure of about 1½ pounds higher in the receiver. *K* is a branch pipe extending from the discharge pipe *D* of the pump *H* through which water is supplied to the ejector *N*. By the employment of a steam ejector *N*, discharging into a receiving chamber *I* in conjunction with a water ejector *M* for drawing away air and vapor from this chamber, a very efficient vacuum-producing plant is, it is claimed, obtained which entirely does away with the necessity for an augmenter surface condenser and for a reciprocating pump.

Cylinder Oil Dehydrating Machine

Separating cylinder oil from exhaust-steam returns has been accomplished with various degrees of success, by means of various devices and methods. A most successful machine for separating cylinder oil from water of condensation has been brought out by the De Laval Separator Company, 165 Broadway, New York City.

This machine is shown in Fig. 1, and consists of an outer chamber which is mounted on a stand. A separating chamber consisting of a cast-iron bowl and

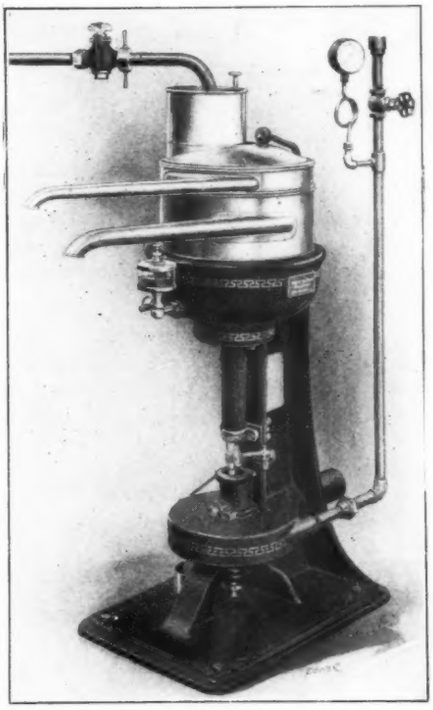


FIG. 1. DE LAVAL DEHYDRATING MACHINE

a series of angular disks revolves in this outer chamber at a speed of 6000 revolutions per minute. These disks are placed 0.035 inch apart, one-half of them having thin lugs secured to the inside and outside surfaces, each lug being 0.035 inch thick. The disks are so placed upon the split-wing tubular shaft, shown in Fig. 2, that the plain ones alternate with those provided with projecting lugs. The total number of disks, 56 in the design of machine shown, form the cone-shaped structure shown in Fig. 3.

The split-wing tubular shaft is provided with a round passage through the center, the bottom end being made in the shape of a hollow cone, while the wings, shown above the cone, are slotted through to the inner passage of the shaft. The disks fit over these projecting wings, as shown in Fig. 3, and are thus held in place as the shaft revolves.

The operation of this device is simple. The tubular shaft and disks revolve at

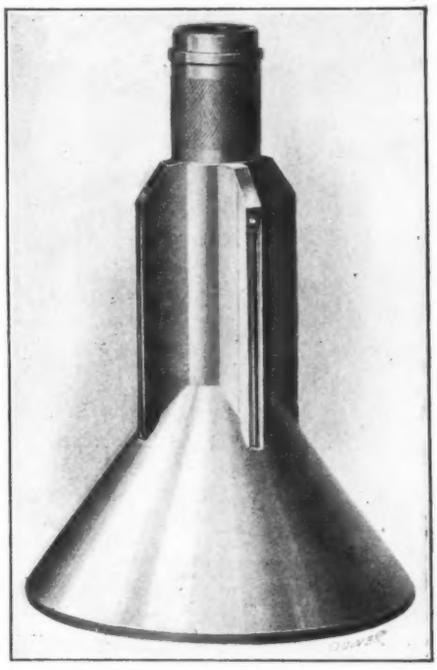


FIG. 2. SPLIT-WING TUBULAR SHAFT

a speed of 6000 revolutions per minute. While running at this speed the water of condensation, with which the cylinder oil mingles, is admitted to the top of the "Alpha" bowl and passes down through the center of the tubular shaft. When the oil reaches the bottom of the cone-shaped section of the shaft it is thrown outward, being subjected to the centrifugal force generated by the revolving bowl. In passing between the disks the water and oil are divided into thin sheets, and each one of the different sections or disks becomes what might be termed a complete and distinct separating factor in itself. The conflicting currents formed in the bowl by the incoming water and oil with the outgoing water and oil are entirely eliminated, and when the water and oil have once been separated there is no possibility of their remixing.

After the water and oil have passed through the hollow tube to the disk or cone-shaped bottom, the mixture is thrown against the inner side of the cone, and then passes up on the inner side of the cone and hollow shaft until it comes to the slot in the wings, when the water and oil pass to the various sections or disks. The water is then thrown out against the under side of each disk, while

the oil adheres to the top side and gradually creeps up from the bottom of the separating disks to a solid cone-shaped disk placed above them, as shown in Fig. 3. From this disk the oil is delivered to the oil-discharge pipe and conveyed to a suitable receiving tank. The water, being heavier, is forced out through the bottom discharge pipe from the lower

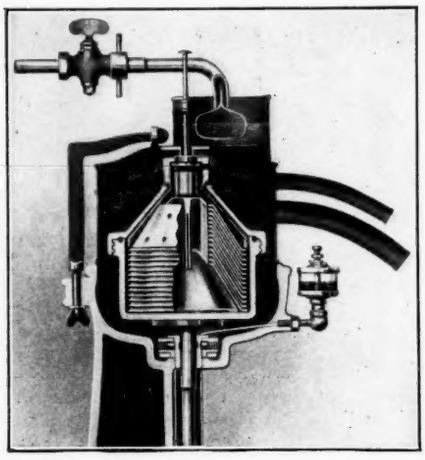


FIG. 3. SECTIONAL VIEW OF SEPARATING DRUM

cone-shaped disk to a receiving tank. Both oil and water pass from the separating disks and upper cone-shaped disks to a passage opening just above each.

Fig. 1 shows a sectional view of a separator equipped with a De Laval turbine of the steam tooth-wheel type. A belt-driven machine can be used when desirable, but the turbine arrangement permits a very compact installation and the steam, after passing through the turbine, is generally allowed to mingle with the water passing through the separator and is returned to the boiler with very little loss of heat.

One of these separators has been in operation in the Singer building power plant, New York City, for some time, through which 65,460 gallons of water is passed every eight hours, and out of seven gallons of cylinder oil used daily throughout the plant, five gallons are reclaimed by the use of the separator. Owing to the large amount of water returned, the machine is of insufficient capacity to handle it all, and, therefore, some water is bypassed to the sewer, which undoubtedly reduces the amount of cylinder oil reclaimed.

The separator is easily cleaned by removing the top of the bowl, when the disks may be lifted out and the interior of the bowl exposed ready for cleaning. The separating bowl on the machine is made of forged material and is said to be absolutely safe and rust-proof.

Spartan Chain Pipe Wrench

One of the features of the Spartan wrench, shown in Fig. 1, is the oblique angle of the teeth with the plane of the jaws, which gives an instantaneous and positive "bite" on the pipe or fitting.

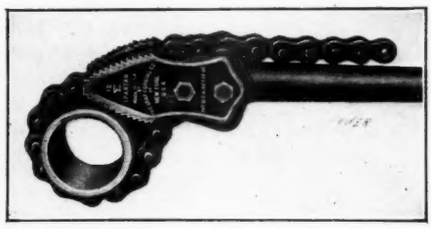


FIG. 1. CHAIN WRENCH APPLIED TO A PIPE

The angle of the teeth also tends to force the jaws together when the wrench is being used, thus securing reinforcement from the end of the handle and relieving the strain on the bolt heads.

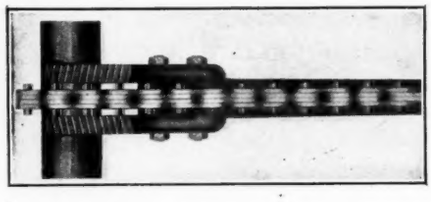


FIG. 2. DETAILS OF CHAIN

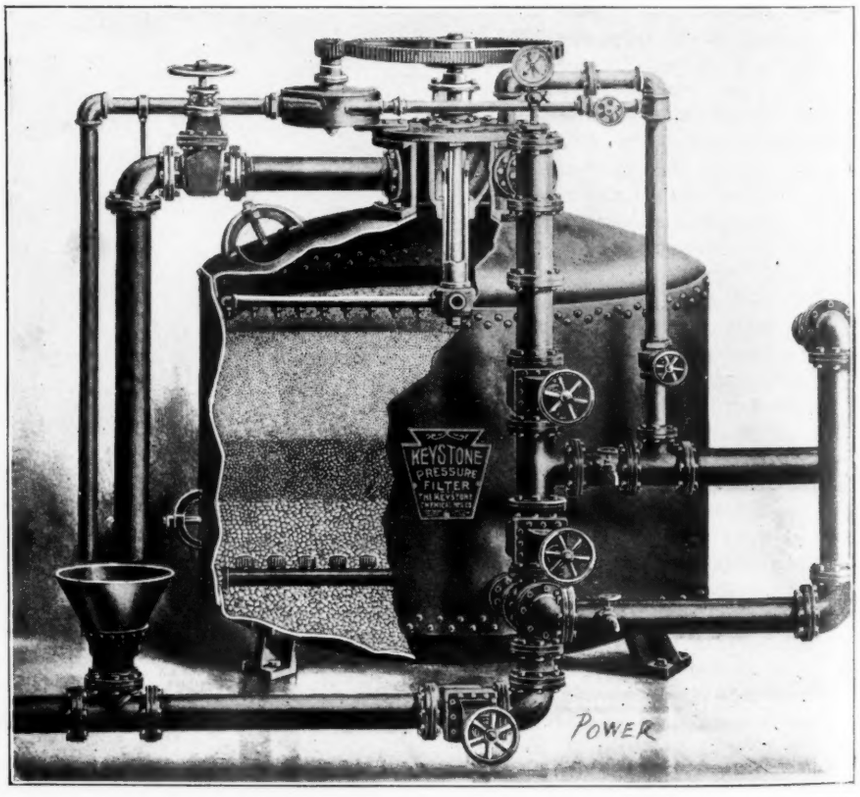
The jaws are reinforced to take up any lateral strain, and the teeth are saw tempered so that they may be sharpened by filing only. The oval shape of the handle gives the maximum strength where the strain is the greatest. The chain passes over the pipe or fitting, as shown in Fig. 2, and engages with a hook formed on the jaws. This pipe wrench is made by the Drop Forging Company, West Side avenue and Fisk street, Jersey City, N. J.

Filter Bed Washing Device

A device for washing the filtering bed free from all slime and silt adhering to the gravel in the pressure filter, placed on the market by the Keystone Chemical Manufacturing Company, of Philadelphia, Penn., is illustrated and described herewith.

Four sprayer arms are placed just above the top of the sand bed. These arms contain small bronze nozzles through which water is forced and are so arranged that each square inch of the top of the bed is broken up, scoured and washed of the lodged impurities. The streams of water are thrown with great force into the sand and at the same time the arms slowly revolve. The top of the filter is fitted with either a water motor or a tight and loose pulley, which operates the gear wheels and turns the sprayer arms. An electric motor of about one-quarter horsepower can also be used to operate the washing arms.

A great saving in time is said to be one of the special features of the new system, as it can be started at once, and the washing-out process takes but a few minutes.



SHOWING FILTER BED-WASHING DEVICE

Vertical Turbo Fans for Forced Draft

The 50-horsepower seven-stage vertical turbo-fan which we illustrate is one of eight designed by the Kerr Turbine Company, of Wellsville, N. Y., for supplying forced draft to the boilers of the United States torpedo boat destroyers "Sterrett" and "Perkins."

These turbo-fans operate at a maximum steam pressure of 265 pounds and noncondensing against five pounds back pressure. The fans, of the American Sirocco type, are placed to take air from the outside through funnels on the deck and discharge it into the fire room through adjustable cone-shaped casings. Two fans, each operating at 1655 revolutions per minute, deliver 40,000 cubic feet of free air per minute into each engine room, maintaining within a pressure equivalent to 4 inches of water.

The installation arrangement is shown in the line diagram. The turbines are made right and left and are arranged in pairs, one pair delivering into each fire room. One unit is bolted directly onto vertical stanchion on each side of the boiler. It is evident from the diagram that the space restrictions are quite severe. Small diameter of the turbine is an important requirement and this was made possible without reducing the power below the desired limit, only by using seven rotors, each 12 inches in diameter. The use of many stages with light rotors of small diameter in these turbines also overcomes trouble from gyroscopic action better than using fewer rotors of larger diameter. Experience has shown that in marine work the gyroscopic action of large heavy turbine wheels running in a horizontal plane and with bearings close together subjects the bearings to heavy side pressure as the boat rocks.

FIG. 1. KERR TURBINE-BLOWER UNIT

The effect of gyroscopic action is made negligible with the smaller wheels and is further minimized in these Kerr turbines by the comparatively long distance between the bearings.

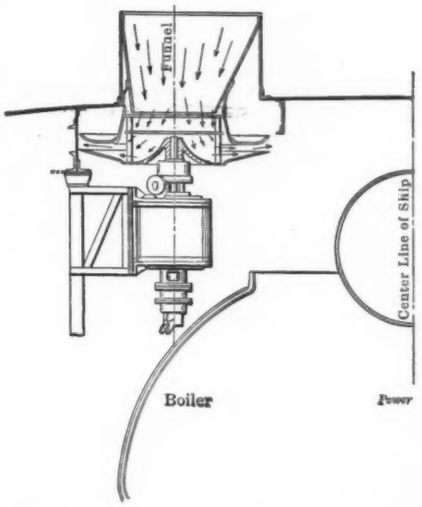


FIG. 2. ARRANGEMENT OF UNIT ON SHIPBOARD

A Self-acting Water Pump

The famous physicist de Montgolfier at the end of the eighteenth century utilized the hydraulic recoil, the enemy of all water conduits, for lifting water by means of what is called a "water ram."

Apart from some minor variations, this primitive apparatus has not been altered. Owing, however, to its somewhat large dimensions, the unavoidable loss of water, and to its caprices, it is seldom used in actual practice.

The novel water ram shown in Fig. 1 and constructed by Messrs. Court and Frères at Romans, France, utilizes the same hydraulic principle in a far more effective manner for lifting water to the upper floors in cases where the pressure is insufficient. The water is conducted into the ram through two pipes *A* and *A'* as shown in the section, Fig. 2. The device is controlled by a pendulum arrangement *B*, which alternately opens the two valves *C* and *D*, allowing the water to pass, and producing by each movement a recoil which lifts the valve *E* or the valve *F*, thus forcing the water upward into conduit *E*.

The hydraulic recoil is similar to a very frequent pulsation and always occurs at the proper moment. The ram is very strong, and takes up but little space. The discharge cock at the bottom is provided for the purpose of cleaning and a key at *H* can be used to start the pendulum in the event of its being obstructed.

The apparatus above described is of remarkable simplicity, and can be utilized wherever there is insufficient pressure.

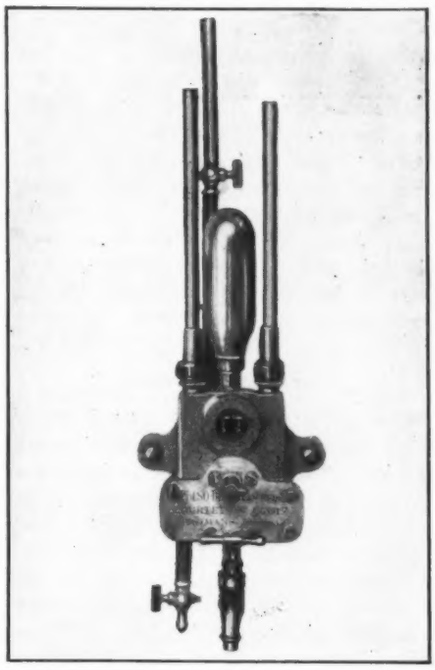


FIG. 1. EXTERNAL VIEW

The percentage of water raised by the ram varies between ⅙ to ⅓ of the available supply, according to the pressure, and the hight to which it is to be raised.

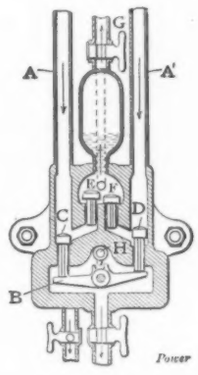


FIG. 2. SECTION THROUGH PUMP

Seventy-five per cent. of the motive force is utilized as a minimum.

The annual convention of the American Order of Steam Engineers is now in session at Philadelphia. The convention opened Monday, June 6, and will continue until Friday, June 10. In point of attendance and in size and quality of exhibits, it is expected that this meeting will excel all previous efforts of this popular organization. The committee have arranged an excellent program of entertainment.

NEW PUBLICATIONS

THE INDICATOR HANDBOOK. By Charles N. Pickworth; Part II. D. Van Nostrand Company, New York. 130 pages; 7x4¼; cloth. Price, 75 cents net.

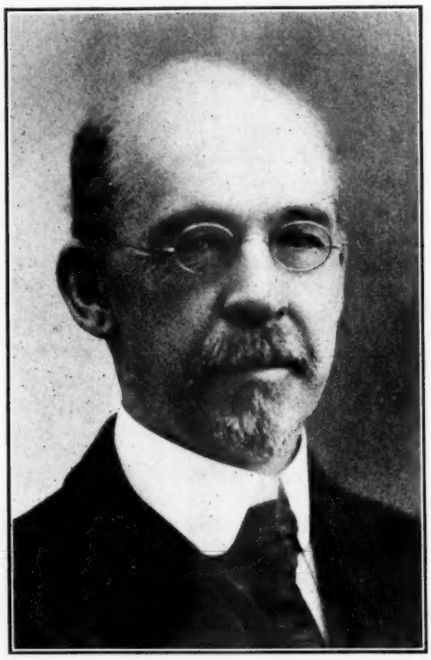
This is the fourth edition of this excellent handbook and this volume is devoted to the analysis of the indicator diagram, horsepower calculations, steam distribution, gas and oil engines, compressors and pumps. It differs from former editions only in the appendix, which contains a table of horsepower constants and a short description of two diagram devices unaccompanied by the illustrations which are needed to make the descriptive matter clear.

A Study in Heat Transmission, by J. K. Clement and C. M. Garland, is issued as Bulletin No. 40 of the engineering experiment station of the University of Illinois. This bulletin is for the technical reader and will be of interest to the student and physicist as well as the designer and operator of heating or cooling apparatus of any description. The results of the experiments apply directly to the problem of increased effectiveness of heating or cooling surfaces, which is a problem at the present moment engaging the attention of engineers. A large portion of the interest in the bulletin lies in the method of experimentation. The results show that the heat transmitted through the walls of a vessel in contact with water may be increased two or three times by increasing the velocity or rate of agitation of the water. Copies of Bulletin No. 40 may be obtained gratis upon application to W. F. M. Goss, director of the engineering experiment station, University of Illinois, Urbana, Ill.

A very artistic catalog, issued by the Alpha Portland Cement Company, Pennsylvania, has just been received. It is bound in a chocolate linen-finished cover, with gilt border lines and a brown ink body, giving a most attractive appearance. The press work and illustrations are of the finest both in design and execution. The catalog deals with Alpha portland cement, giving valuable information regarding the methods of how to proportion cement mixtures for various purposes, and how to mix the different ingredients which form the cement when it is ready for laying, also design of forms of cement construction and the effect of atmospheric conditions upon concrete work. Sidewalks, pavements, curbing and gutter work are dealt with, also concrete surfaces, reinforced concrete, fireproofing, concrete blocks, waterproofing and sea-water construction. A great many "pointers" can also be obtained from the section dealing with what cement can do for the owner of the home, the farm and other real estate. It is illustrated by many excellent halftones showing the result of concrete construction of various kinds.

OBITUARY

On May 22 William E. Crane died at Duluth, Minn., after a short illness. He was born in Burlington, Conn., in 1847 and after receiving his early education in the local schools, at the age of fourteen began to apply himself to engineering. At sixteen he took charge of a small engine at Bristol and later came to Waterbury, Conn., where for over 25 years he



WILLIAM E. CRANE

was connected with the Benedict & Burnham Company. After severing his connection with that firm he became consulting engineer for the New England Engineering Company and designed several power plants of considerable importance, notably, that of the Kings County Electric Light and Power Company, the Passaic Electric Light and Power Company and the Albany & Hudson Railway Company. Later, he was chief engineer at the Hotel Astor in New York City, but failing health forced him to resign and seek the climate of Minnesota.

Mr. Crane was a member of the National Association of Steam Engineers and the American Society of Mechanical Engineers, and was the author of a treatise on "American Stationary Engineering" besides having the distinction of being the first man to use the double eccentric on a Corliss engine. In addition to his engineering activities he took a keen interest in public affairs and contributed much to the press upon social conditions.

He is survived by a widow and four children.

B. C. Alvord, secretary and treasurer of the Shultz Belting Company, St. Louis, Mo., died May 10, 1910.

PERSONAL

Lamar Lyndon, consulting engineer in New York City in mechanical and electrical lines, has removed his offices from 56 Pine street to the Knickerbocker Trust building, 60 Broadway.

The Pawling & Harnischfeger Company, Milwaukee, Wis., a manufacturer of electric cranes and hoists, has recently appointed Albert B. Bowman, 720 North Second street, St. Louis, Mo., as a special sales representative.

SOCIETY NOTES

Robert Fulton Association, Illinois No. 28, National Association of Stationary Engineers, will celebrate its twentieth anniversary with an informal dinner, at the Chicago Automobile Club, on Thursday, June 9, 1910.

To attend the meeting of the National Gas and Gasoline Engine Trades Association at Cincinnati, June 14, 15 and 16, a party will leave Chicago at 12 p.m., June 13, via the Pennsylvania railroad, arriving at Cincinnati 8 a.m. Tuesday morning. Those in the West and Northwest desiring reservations with this party may communicate with H. W. Jones, 1259 People's Gas building, Chicago.

Of the papers to be presented at the annual convention of the American Institute of Electrical Engineers, which will be held at the Waumbek, Jefferson (White Mountains), N. H., the following will interest POWER readers: Modern Oil Switch, by A. R. Cheyney; Determination of Transformer Regulation under Load Conditions and Some Resulting Investigations, by Adolph Shane; Interaction of Flywheels and Motors when Driving Roll Frames by Induction Motors, by F. G. Gasche; Power Economy in Electric Railway Operation—Coasting, Clock Tests on the Manhattan Elevated Railway, by H. S. Putnam.

NEW INVENTIONS

Printed copies of patents are furnished by the Patent Office at 5c each Address the Commissioner of Patents, Washington, D. C.

PRIME MOVERS

ROTARY ENGINE. George W. Bartlett, Tacoma, Wash., assignor to George W. Bartlett Rotary Engine Company, Tacoma, Wash., a Corporation of Washington. 957,860.

ELASTIC FLUID TURBINE. Elihu Thomson, Swampscott, Mass., assignor to General Electric Company, a Corporation of New York. 957,915.

TURBINE. Richard C. Frohlich, Philadelphia, Penn. 957,944.

INTERNAL COMBUSTION MOTOR. Carl A. Hult and Oscar W. Hult, Stockholm, Sweden. 957,965.

CURRENT MOTOR. Rudolph C. Schreiber, Harvey, Ill. 958,014.

WATER MOTOR. Harry W. Mezger, Springfield, Ohio. 958,152.

GAS ENGINE. Jacob A. Baab, New York, N. Y. 958,211.

ROTARY STEAM ENGINE. George A. Metcalf, Walter C. Rocheleau, and Louis T. Rocheleau, Woonsocket, R. I. 958,416.

TURBINE. Charles A. Parsons, Newcastle-upon-Tyne, England. 958,430.

WAVE OR CURRENT MOTOR. James E. Bennett, Atlantic City, N. J. 958,467.

WATER MOTOR. John N. Hardy, Columbus, Ohio. 958,492.

ELASTIC FLUID MOTOR. John I. Shirley, Mexico, Mexico. 958,553.

ROTARY ENGINE. Benjamin F. Wickersham, Pakota, Ill., assignor of one-third to Thomas B. Walker and one-third to John Pugh. 958,571.

ENGINE. George L. Borden, Campbell, N. Y. 958,583.

CURRENT MOTOR. Offie M. Butcher, Coeur d'Alene, Idaho. 958,590.

WATER TURBINE. Ernst A. Nilsen, Christiania, Norway. 958,670.

TURBO UNIPOLAR GENERATOR. Otto Schulz, Schlachtenesee, near Berlin, Germany. 958,681.

BOILERS, FURNACES AND GAS PRODUCERS

FURNACE. Alfred Fisher, Chicago, Ill. 957,783.

FURNACE-ARCH CONSTRUCTION. Peter Isles, Swissvale, Penn. 958,130.

OIL BURNER. Charles W. Sievert, Los Angeles, Cal., assignor of one-half to Albert Henry Sievert, Los Angeles, Cal. 958,330.

STEAM GENERATOR. Joseph Buckley, Methuen, Mass. 958,358.

IGNITION ARCH FOR FURNACES. William M. Duncan, Alton, Ill. 958,379.

OIL-BURNING FURNACE. Clayton C. Phipps, San Diego, Cal. 958,433.

STEAM GENERATOR. Rudolph Dunkel, Boston, Mass. 958,606.

HYDROCARBON BURNER. Thomas H. Clark and Joseph H. Nequette, Los Angeles, Cal. 958,692.

POWER PLANT AUXILIARIES AND APPLIANCES

CENTRIFUGAL GOVERNOR. Fred W. Bentley, Schenectady, N. Y., assignor to General Electric Company, a Corporation of New York. 957,861.

BRAIDED HOSE. Henry Z. Cobb, Malden, Mass., assignor to Revere Rubber Company, Boston, Mass., a Corporation of Massachusetts. 957,867.

CENTRIFUGAL GOVERNOR. Oscar Junggren and Fred W. Bentley, Schenectady, N. Y., assignors to General Electric Company, a Corporation of New York. 957,886.

PACKING FOR ELASTIC FLUID TURBINE SHAFTS. Oscar Junggren, Schenectady, N. Y., assignor to General Electric Company, a Corporation of New York. 957,887.

GOVERNING MECHANISM FOR ELASTIC FLUID TURBINES. Walter Kieser, Berlin, Germany, assignor to General Electric Company, a Corporation of New York. 957,888.

GOVERNING MECHANISM FOR ELASTIC FLUID TURBINES. Walter Kieser, Berlin, Germany, assignor to General Electric Company, a Corporation of New York. 957,889.

GOVERNING MECHANISM FOR ELASTIC FLUID TURBINES. Paul Olivier, Paris, France, assignor to General Electric Company, a Corporation of New York. 957,898.

GOVERNING MECHANISM FOR TURBINES. Richard H. Rice, Lynn, Mass., assignor to General Electric Company, a Corporation of New York. 957,902.

OIL-CUP CLOSURE. Edward J. Nahm and Warren L. Nahm, St. Louis, Mo. 957,994.

VALVE. Frederick C. Snow, Chicago, Ill., assignor, by mesne assignments to Conkling Company, Chicago, Ill., a Corporation of Illinois. 958,021.

LIQUID FUEL TANK. Joseph A. Steinmetz, Philadelphia, Penn. 958,025.

WATER GAGE. Frank Baker, Dalton, N. Y. 958,072.

LOCK-JOINT COUPLING. John K. Bulger, San Francisco, Cal., assignor to the Bulger Lock Coupling Company, San Francisco, Cal., a Corporation of California. 958,086.

STRAINER FOR OIL AND WATER WELLS. Harry R. Decker, Houston, Tex. 958,100.

TUBE CLEANER. Elmer E. Hauer, Springfield, Ohio, assignor to the Lagonda Manufacturing Company, Springfield, Ohio, a Corporation of Ohio. 958,118.

CARBURETER. Albert Howarth, Providence, R. I., assignor by mesne assignments, to Star Carbureter and Supply Company, Providence, R. I., a Corporation of Rhode Island. 958,128.

ROTARY PUMP. Justus R. Kinney, Dorchester, Mass. 958,136.

GOVERNOR. George B. Nelson, Redfield, Iowa. 958,159.

BOILER-TUBE CLEANER. Henry F. Weinland, Springfield, Ohio, assignor to the Lagonda Manufacturing Company, Springfield, Ohio, a Corporation of Ohio. 958,202.

REGULATING VALVE. Albert M. Allen, Cleveland, Ohio. 958,206.

CYLINDER LUBRICATION. John G. Leyner, Denver, Colo., assignor to the George J. Leyner Engineering Works Company, Littleton, Colo., a Corporation of Colorado. 958,260.

POWER-TRANSMITTING PULLEY. William A. Owen, Johnson City, Tenn. 958,274.

ROTARY VALVE. Robert W. Riordan, Brooklyn, N. Y. 958,313.

VACUUM PUMP. John T. Wilkin, Connersville, Ind., assignor to the Connersville Blower Company, Connersville, Ind., a Corporation of Indiana. 958,345.

VALVE MECHANISM FOR WATER COLUMNS. Frank C. Anderson, Cincinnati, Ohio, assignor to American Valve and Meter Company, Cincinnati, Ohio, a Corporation of West Virginia. 958,351.

APPARATUS FOR CLEANING FIRE TUBES OF BOILERS. Martin Domiszewski, Kolomea, Austria-Hungary. 958,376.

STEAM NOZZLE. Joseph W. Stillwell, New York, N. Y. 958,444.

STARTING DEVICE FOR VAPOR APPARATUS. Percy H. Thomas, East Orange, N. J., assignor to Cooper Hewitt Electric Company, New York, N. Y., a Corporation of New York. 958,445.

VALVE. Dixon E. Washington, Chicago, Ill., assignor of one half to Charles W. Patton, Chicago, Ill. 958,451.

CARBURETER. George E. Cook, New York, N. Y., assignor of one-half to Philip Schlosser, New York, N. Y. 958,476.

VALVE. John W. McCown, Butler, Penn., assignor of one-half to Newton C. McCullough, Butler, Pa. 958,521.

EXHAUST REGENERATING STEAM AND WATER HEATER COMBINED. Stephen H. Hale, St. Joseph, Mo. 958,636.

COMBINATION VALVE AND METER. Edward J. Moore, Cleveland, Ohio. 958,664.

ELECTRICAL INVENTIONS AND APPLIANCES

COIL FOR DYNAMO ELECTRIC MACHINES. Gustave Chovan, Pittsburg, Penn., assignor to Westinghouse Electric and Manufacturing Company, a Corporation of Pennsylvania. 957,866.

RELAY. Archibald S. Cubitt, Schenectady, N. Y., assignor to General Electric Company, a Corporation of New York. 957,870.

COIL FOR DYNAMO ELECTRIC MACHINES. William T. Hensley, Wilkinsburg, Penn., assignor, by mesne assignments to Westinghouse Electric and Manufacturing Company, East Pittsburg, Penn., a Corporation of Pennsylvania. 957,882.

ELECTRIC VIBRATOR. Sampson W. Moon, Chicago, Ill. 957,982.

ELECTRIC TUBE LAMP AND SIMILAR DEVICE. Daniel M. Moore, Newark, N. J., assignor to Moore Electrical Company, New York, N. Y., a Corporation of New York. 957,983.

INCANDESCENT LIGHT. Robert D. Cody, Chicago, Ill. 958,094.

CURRENT REDUCER. Burton L. Hadfield and Harry A. Hall, Wausau, Wis. 958,111.

ENGINEERING SOCIETIES

AMERICAN SOCIETY OF MECHANICAL ENGINEERS

Pres., George Westinghouse; sec., Calvin W. Rice, Engineering Societies building, 29 West 39th St., New York. Monthly meetings in New York City.

NATIONAL ELECTRIC LIGHT ASSOCIATION

Pres., Frank W. Frueauff, Denver, Colo.; sec. and treas., Frank M. Tait. Association York.

AMERICAN SOCIETY OF NAVAL ENGINEERS

Pres., Engineer-in-Chief Hutch I. Cone, U .S. N.; sec. and treas., Lieutenant Henry C. Dinger, U. S. N., Bureau of Steam Engineering, Navy Department, Washington, D. C.

AMERICAN BOILER MANUFACTURERS' ASSOCIATION

Pres., E. D. Meier, 11 Broadway, New York; sec., J. D. Farasey, cor. 37th St. and Erie Railway, Cleveland, O.

WESTERN SOCIETY OF ENGINEERS

Pres., J. W. Alvord; sec., J. H. Warder, 1735 Monadnock Block, Chicago, Ill.

ENGINEERS' SOCIETY OF WESTERN PENNSYLVANIA

Pres., E. K. Morse; sec., E. K. Hiles, Oliver building, Pittsburg, Penn. Meetings 1st and 3d Tuesdays.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS

Pres., L. B. Stillwell; sec., Ralph W. Pope, 33 W. Thirty-ninth St., New York. Meetings monthly, excepting July and August.

AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS.

Pres., Prof. J. D. Hoffman; sec., William M. Mackay, P. O. Box 1818, New York City. Next semi-annual meeting, St. Louis, Mo., June 30 and July 1, 1910.

NATIONAL ASSOCIATION OF STATIONARY ENGINEERS

Pres., William J. Reynolds, Hoboken, N. J.; sec., F. W. Raven, 325 Dearborn street, Chicago, Ill. Next convention, Rochester, N. Y., September, 1910.

UNIVERSAL CRAFTSMEN COUNCIL OF ENGINEERS

Grand Worthy Chief, W. S. Cadwell, Chicago, Ill.; sec., Thomas H. Jones, 244 Eighth street, N. E., Washington, D. C. Next convention, Buffalo, N. Y., August 2-5, 1910.

AMERICAN ORDER OF STEAM ENGINEERS

Supr. Chief Engr., Frederick Markoe, Philadelphia, Pa.; Supr. Cor. Engr., William S. Wetzler, 753 N. Forty-fourth St., Philadelphia, Pa.

NATIONAL MARINE ENGINEERS BENEFICIAL ASSOCIATIONS.

Pres., William F. Yates, New York, N. Y.; sec., George A. Grubb, 1040 Dakin street, Chicago, Ill. Next meeting, St. Louis, Mo., January 16-21, 1911.

OHIO SOCIETY OF MECHANICAL ELECTRICAL AND STEAM ENGINEERS

Pres., O. F. Rabbe; sec. and treas., Prof. F. E. Sanborn, Ohio State University, Columbus, Ohio.

INTERNATIONAL MASTER BOILER MAKERS' ASSOCIATION

Pres., A. E. Brown; sec., Harry D. Vaught, 95 Liberty street, New York.

INTERNATIONAL UNION OF STEAM ENGINEERS

Pres., Matt. Comerford; sec., Robert A. McKee, 606 Main St., Peoria, Ill. Next convention, Denver, Colo., September, 1910.

NATIONAL DISTRICT HEATING ASSOCIATION.

Pres., A. C. Rogers, Toledo, O.; sec. and treas., D. L. Gaskill, Greenville, O.

Moments with the Ad. Editor

A department for subscribers edited by the advertising service department of Power and the Engineer.

Have you ever met the "man who doesn't advertise?"

No, you haven't, because he doesn't exist. Yet there's many a manufacturer who'll swear that he doesn't spend a red cent for publicity.

He's the same party who gets out a catalog, pastes labels on his packing cases, stencils his name and address on every shipment, puts name plates on his product, hangs signs on his shop, pays extra to have his name and address in boldface type in the telephone directory, makes an Annual Institution of the near-silver match-box sent to all customers, falls for the appeal from the strawberry blonde with space to sell in the program of the Regular Annual Oyster Supper of the M. E. Church and talks his product to every man he can rope and throw long enough to tell him about the latest improvements he's made on "the best machine on earth."

Everybody advertises—only some are more scientific in their methods.

Even the professional man whose code of ethics demands that he carefully conceal his advertising beneath a cloak of sophistry, he advertises.

Some physicians could draw a press agent's princely salary if they'd turn their ability in the right direction.

Look at Dr. Jones, for instance, who has Mrs. Jones send for him while he's at the theatre. It's a great scheme. Imposing stage manager walks down stage, holds up hand amid breathless interest of the audience and gravely announces "a call for Dr. Jones of West Main street at the box office."

Exit Dr. Jones with the eyes of the assemblage focused upon him.

Much interest added by voice from gallery—"If it's a girl, Doc, call her Gladys."

The "man who doesn't advertise" travels the by-paths. If one-half of the ingenuity displayed in finding the by-paths of advertising were exercised in locating the quickest and best methods for traveling the highway—the macadamized boulevard—there would be less talk of advertising wastes and more of advertising profits.

After all, profitable advertising is simply a matter of "finding the way."

Probably all advertising does some good—certainly some does more than others.

Our claim is that the most profitable advertising for any power plant device is possible through the advertising pages of technical papers devoted to this field.

That all other good forms of advertising are supplemental and should so be considered.

Because this paid-for paper automatically reaches the *progressive* men of the industry.

And advertising aimed at the progressive man is well aimed. The waste of random shooting is eliminated.

There are three recognized schools of medicine—the Allopathic, the Homeopathic and the Eclectic.

Broadly defined, the Allopath overdoses, the Homeopath underdoses and the Eclectic does whichever he blame pleases.

None of the schools speaks a good word for the others, which accounts for the exodus toward Christian Science, Physical Torture, New Thought, Fletcherism, Starvation and Eusapia Palladino.

Advertisers, that is to say, *some* advertisers, are getting off the main track. Part of this is due to the advertiser, most of it must be laid to the man who tries to boost his own pet scheme by knocking all the others. "Hammering" reacts anyway. Confusion of confidence is the same as none at all.

Advertising in any good technical journal is a badge of responsibility—

And so recognized by the readers of that paper.